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TITLE

**THE ORGANIC ORIGIN OF FOOD:
THE DEVELOPMENT OF A SCIENTIFIC CONCEPT
IN CHILDREN AGED FOUR TO EIGHT**

Jennifer Beatrice Cumming

Thesis submitted for the degree of Doctor of Philosophy

University of Durham

School of Education

2002

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14 APR 2003

TABLE OF CONTENTS

TABLE OF CONTENTS	2
LIST OF TABLES	9
LIST OF FIGURES	11
LIST OF ILLUSTRATIONS	12
LIST OF APPENDICES	13
DECLARATION	14
ACKNOWLEDGEMENTS	15
ABSTRACT	16

PART ONE: THE THEORETICAL COMPONENT OF THE THESIS

CHAPTER ONE: INTRODUCTION TO THE THESIS

1.1 Introduction	17
1.2 The theoretical background for the research	18
1.3 The aim of the research	18
1.4 The rationale for the research	19
1.5 The relevance of the research	19
1.6 The originality of the research	20
1.7 The operationalisation of the research questions	21
1.8 Overview of the thesis	21

CHAPTER TWO: THE CONSTRUCTIVIST VIEW OF LEARNING IN SCIENCE

2.1 Introduction	24
2.2 Outline	24
2.3 The evolution of beliefs about the nature of science and how it is learned	25
2.4 The limitations of constructivism	28
2.5 Constructing knowledge through the senses	30
2.5.1 The personal nature of sensory knowledge construction	31
2.5.2 The formation of concepts	32
2.5.3 The construction of knowledge without conscious intent	33
2.5.4 The translation of sensory knowledge into language	35
2.5.4.1 Karmiloff-Smith's model of Representational Redescription	35
2.5.4.2 Discussion of Karmiloff-Smith's model	37
2.5.4.3 Karmiloff-Smith's model and metacognition	38
2.6 The socio-cultural aspect of the construction of knowledge	39
2.6.1 The development of interpersonal communication	40
2.6.2 General ideas about the social construction of knowledge	40
2.6.3 Interpersonal communication in school settings	41
2.6.4 A socio-cultural perspective on science lessons	44
2.7 Conclusion	46

CHAPTER THREE: THE FORMATION OF IDEAS ABOUT BIOLOGY IN YOUNG CHILDREN: A REVIEW OF THE DEVELOPMENTAL LITERATURE

3.1 Introduction	47
3.2 Outline	47
3.3. The work of Jean Piaget	47
3.3.1 Piaget's stage theory	48
3.3.2 Criticisms of Piaget's stage theory	50
3.3.3 The individual construction of knowledge	54
3.3.4 The question of innateness and the modularity of mind	55

3.4 Post-Piagetian research on the development of children's biological ideas	58
3.4.1 The construction of a theory: post-Piagetian research on the meaning of 'alive'	58
3.4.2 Further work on theory construction: post-Piagetian research on the flowering plant life cycle and inheritance	65
3.4.3 Socio/cultural factors in cognitive development	68
3.5 Developmental research in cognitive neuroscience	72
3.5.1 Domain-general changes during development	73
3.5.2 The evidence for innateness	75
3.6 The challenges of working with young children	77
3.7 Conclusion	80

CHAPTER FOUR: THE DEVELOPMENT OF BIOLOGICAL KNOWLEDGE AND UNDERSTANDING IN YOUNG CHILDREN: A REVIEW OF THE LITERATURE

4.1 Introduction	82
4.2 Outline	82
4.3 The scope of the review	82
4.4 Findings	84
4.4.1 The meaning of the word 'alive'	85
4.4.2 The development of factual knowledge	85
4.4.3 The development of understanding	90
4.4.4 Persistent misconceptions	96
4.4.5 Intriguing responses in younger children	97
4.4.6 Inconsistent responses	98
4.5 The research methodologies	99
4.5.1 The design of the studies	99
4.5.2 The research instruments	101
4.5.3 Analysis of the data	103
4.6 Conclusion	103

**PART TWO: THE EMPIRICAL ENQUIRY INTO THE DEVELOPMENT
OF CHILDREN'S KNOWLEDGE AND UNDERSTANDING**

**CHAPTER FIVE: CHILDREN'S KNOWLEDGE AND
UNDERSTANDING OF THE ORGANIC ORIGIN OF
FOOD: METHODOLOGY FOR THE EMPIRICAL
ENQUIRY**

5.1 Introduction	105
5.2 Outline	105
5.3 The research design	105
5.4 Participants	105
5.4.1 The Local Education Authority	106
5.4.2 The schools	106
5.4.3 The teachers	108
5.4.4 The parents	108
5.4.5 The children	108
5.5 Revision of the interview plan	108
5.6 The pilot studies	109
5.6.1 Pilot One	109
5.6.2 Pilot Two	110
5.6.3 Pilot Three	111
5.7 The research instrument	111
5.7.1 Rationale	111
5.7.2 Scientific background	112
5.7.3 Construction of the research instrument	114
5.7.4 The interview schedule	116
5.8 Conduct of the interviews	141
5.8.1 Timing of the interviews	141
5.8.2 Organisation of the interviews	141
5.9 Data analysis	141
5.9.1 Content analysis	142
5.9.2 Discourse analysis	147
5.10 Conclusion	147

CHAPTER SIX: EMPIRICAL FINDINGS RELATING TO CHILDREN'S KNOWLEDGE AND UNDERSTANDING AT AGE FOUR, SIX AND EIGHT

6.1 Introduction	148
6.2 Outline	148
6.3 Findings	148
6.3.1 Children's factual knowledge about the origin of food items	149
6.3.2 Children's factual knowledge about food producers	166
6.3.3 Children's understanding that plants are the ultimate source of food	175
6.3.4 Analysis of responses by individual children	178
6.3.5 Children's response to the interviews	181
6.4 Discussion	184
6.4.1 Increase in knowledge	185
6.4.2 Growth in understanding	186
6.4.3 Intriguing responses	187
6.4.4 Responses which could indicate the basis of misconceptions	196
6.4.5 The relevance of children's responses	198
6.5 Conclusion	198

PART THREE: THE EMPIRICAL ENQUIRY INTO THE SOURCE OF CHILDREN'S KNOWLEDGE

CHAPTER SEVEN: REVIEW OF THE LITERATURE RELATING TO LEARNING OPPORTUNITIES OUTSIDE SCHOOL

7.1 Introduction	200
7.2 Outline	202
7.3 Opportunities for learning outside school	202
7.4 The methodologies employed	206
7.5 Autobiographical memory research	209
7.6. Conclusion	211

CHAPTER EIGHT: CHILDREN'S OPPORTUNITIES FOR LEARNING: METHODOLOGY FOR THE EMPIRICAL ENQUIRY

8.1 Introduction	213
8.2 Outline	213
8.3 The research design and methodology	214
8.4. The participants	215
8.5 Operationalisation	215
8.5.1 Rationale	215
8.5.2 The research questions	216
8.5.3 Gathering the data	217
8.6 Analysis of the data	223
8.6.1 Content analysis	223
8.6.2 Discourse analysis	224
8.7 Discussion	225
8.7.1 School-based data	225
8.7.2 Data provided by parents	226
8.7.3 Data provided by children	227
8.7.4 The ethnographic approach	227
8.8 Conclusion	228

CHAPTER NINE: CHILDREN'S OPPORTUNITIES FOR LEARNING ABOUT THE ORGANIC ORIGIN OF FOOD: THE EMPIRICAL FINDINGS

9.1 Introduction	230
9.2 Outline	230
9.3. An inventory of the sources of children's ideas	230
9.3.1 The inventory table	230
9.3.2 The ethnographic narrative	232
9.3.2.1 Direct, first-hand experiences	232
9.3.2.2 Secondary (indirect) experiences	240
9.4 The nature of specific experiences and their relevance to children's ideas	245
9.5 Children's attribution of the sources of their knowledge	259

9.6 Reliability and validity of the data	264
9.6.1 Statements from children	264
9.6.2 Family-based experiences at Sea View and Manor House	264
9.6.3 School-based experiences	265
9.7 Discussion and conclusion	266

PART FOUR: CONCLUSION OF THE THESIS

CHAPTER TEN: CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction	268
10.2 Outline	268
10.3 The development of factual knowledge	268
10.4 The development of understanding	272
10.5 Misleading statements in young children	272
10.6 The development of a misconception	273
10.7 Recommendations for educators	273
10.8 Evaluation of the project	275

BIBLIOGRAPHY	278
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LIST OF TABLES

TABLE 3.1	Post-Piagetian research on the properties of life	59
TABLE 3.2	Research on flowering plant life cycle and inheritance	66
TABLE 3.3	The influence of culture in understanding the properties of life	69
TABLE 4.1	The research reviewed	83
TABLE 5.1	Children who took part in the interviews	114
TABLE 6.1	Statements about the origin of the eggs shown in the photograph	152
TABLE 6.2	Statements about the origin of meat	154
TABLE 6.3	Statements about its origin in response to the milk picture	156
TABLE 6.4	Statements about the origin of lettuce	158
TABLE 6.5	Statements about the origin of tomatoes	159
TABLE 6.6	Statements about the origin of cheese	161
TABLE 6.7	Statements about the origin of chipped potatoes	162
TABLE 6.8	Statements about the ingredients of bread	164
TABLE 6.9	Statements about the origin of corn flakes	165
TABLE 6.10	Statements about food for hens	170
TABLE 6.11	Statements about food for cows	173
TABLE 6.12	Items needed for plant growth (some children mentioned several items)	175
TABLE 6.13	Children's ideas about the effect of plant death	178
TABLE 6.14	Frequency of irrelevant statements made by thirteen four-year-old children	183
TABLE 7.1	Opportunities for science learning outside school	202
TABLE 7.2	Opportunities for learning at home: cognitive stimulation and language	204
TABLE 7.3	Opportunities for learning language and mathematics at home and the development of attitudes to learning	206
TABLE 9.1	Classified inventory of children's sources of knowledge about the organic origin of food	231
TABLE 9.2	Content of conversations about food	244
TABLE 9.3	Children's sources of knowledge that eggs come from hens	248
TABLE 9.4	Children's sources of knowledge that meat comes from animals	249

TABLE 9.5	Children's sources of knowledge that milk comes from cows' udders	250
TABLE 9.6	Children's sources of knowledge that fruit and salad items are grown on plants	251
TABLE 9.7	Children's sources of knowledge that cheese is made from milk	252
TABLE 9.8	Children's sources of knowledge that chips are made from potatoes	253
TABLE 9.9	Children's sources of knowledge that bread is made from flour	254
TABLE 9.10	Children's sources of knowledge that corn flakes are made from corn	255
TABLE 9.11	Children's sources of knowledge about food for hens	256
TABLE 9.12	Children's sources of knowledge that cows eat grass	257
TABLE 9.13	Children's sources of knowledge about the needs of plants	258
TABLE 9.14	Summary of the sources of children's ideas in order of prevalence	266

LIST OF FIGURES

FIGURE 1.1	The structure of the thesis	22
FIGURE 2.1	The construction of scientific concepts and theories	26
FIGURE 2.2	Illustration of Representational Redescription	37
FIGURE 5.1	Concept map for interview development	115
FIGURE 6.1	Statements about the origin of eggs shown in the photograph	152
FIGURE 6.2	Appropriate statements for the origin of eggs	153
FIGURE 6.3	Statements about the origin of meat	155
FIGURE 6.4	Statements about milk (in response to two pictures)	156
FIGURE 6.5	Statements about the origin of lettuce	157
FIGURE 6.6	Statements about the origin of tomatoes	159
FIGURE 6.7	Statements about the origin of cheese	160
FIGURE 6.8	Statements about the origin of chipped potatoes	162
FIGURE 6.9	Statements about the ingredients of bread	163
FIGURE 6.10	Statements about the origin of corn flakes	165
FIGURE 6.11	Statements about food for hens	170
FIGURE 6.12	Statements about food for cows	173
FIGURE 6.13	Items needed for plant growth	175
FIGURE 6.14	Children's ideas about the effect of plant death	177
FIGURE 6.15	Individual scores at age four	178
FIGURE 6.16	Individual scores at age six	179
FIGURE 6.17	Individual scores at age eight	279
FIGURE 8.1	Components of the study	217
FIGURE 8.2	Sources of data	218
FIGURE 9.1	Key for the individual tables	247
FIGURE 10.1	The sources of children's knowledge	271

LIST OF ILLUSTRATIONS

1. Eggs	118
2. Meat	120
3. Milk	122
4. Cheese	124
5. Hens	126
6. Cow	128
7. Lettuce	130
8. Tomatoes	132
9. Chipped potatoes	134
10. Bread	136
11. Corn flakes	138
12. Onions	140

LIST OF APPENDICES

APPENDIX I	Initial letter to parents	295
APPENDIX II	Examples of semi-structured child interview typescripts	296
APPENDIX III	Spread-sheets of data from semi-structured child interviews	320
APPENDIX IV	Scores from semi-structured child interviews	336
APPENDIX V	Parent diary instructions and schedule	340
APPENDIX VI	Example of a parent diary	342
APPENDIX VII	Parent questionnaire	350
APPENDIX VIII	Nursery cooking transcript	351

DECLARATION

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ACKNOWLEDGEMENTS

I wish to thank my supervisor, Joy Palmer, for helping me to set off on the right track, for encouraging me to present my work at conferences and for staying with me to completion despite her increasing administrative duties.

Thanks also to Mike Byram, for all the seminars and discussions which have been essential to my progress.

My two grown-up children deserve thanks as well. Thanks to my daughter, Jos, for all those supportive long distance telephone conversations when the going was tough. Last but by no means least, thanks to my son, Rod, for those weekend visits acting as my information technology advisor.

ABSTRACT

The organic origin of food: the development of a scientific concept in children aged four to eight

Jennifer B. Cumming

Thesis submitted for PhD 2002

Educators have discovered that adolescents commonly hold misconceptions in science which interfere with future learning and are difficult to eradicate. However, although early informal learning experiences have been suggested as the source of these ideas, the process by which young children develop both sound knowledge and misconceptions in science has not been elucidated. This research, which is exploratory in nature, is a study of the development of just one concept in young children in the hope that some apparently contradictory evidence can be reconciled.

The empirical enquiry was conducted in two parts:

1. A cross-sectional design was employed with thirty children at each age of four, six, and eight. Semi-structured individual interviews probed children's knowledge of food-related factual items and their understanding that people depend upon plants either directly or indirectly for their food.
2. A qualitative enquiry was engaged to discover the experiences of young children, both inside and outside school, which might contribute to their knowledge about the origin of food.

Children's responses indicate an increase in factual knowledge with age. Although this can be linked primarily to their practical experiences, video film and adult explanation rather than books played their part as well. The children themselves frequently mentioned family-based experiences as the source of their knowledge. There was no significant correlation between factual knowledge and understanding, indicating the possible existence of an intervening process linking the two.

On many occasions the younger children made statements which could inadvertently mislead the questioner to underestimate the extent of their knowledge. However, early signs of a scientific misconception which is known to cause problems for adolescent learners were found. This was not the result of faulty information provided by adults and could easily be overlooked. Insight from recent developments in cognitive science can help both to explain these findings and also in the design of improved pedagogic strategies.

PART ONE: THE THEORETICAL COMPONENT OF THE THESIS

CHAPTER ONE

INTRODUCTION TO THE THESIS

1.1 Introduction

This thesis arises from the author's interest in how children learn. However, only one small aspect of such an enormous topic can be chosen for doctoral study by a lone researcher. Therefore the topic selected for this research is the development of a single concept: the way in which biological knowledge and understanding of the organic origin of food arises in young children.

The organic origin of food was chosen as the topic for study because it is a fundamental biological concept which has received little attention from early years researchers. Notwithstanding this lack of regard, the concept is fundamental because it is concerned with the basic need of animals and plants for nutrition in order to sustain life. Understanding that there is an organic origin for all food items requires an appreciation that animal food originates either directly or indirectly from plants.

The age range of four to eight years was chosen for a number of reasons. The age of four is the youngest at which access and communication is straightforward. From a maturational perspective, some critical and recognisable changes take place in children's cognition from the age of four to eight years. From the educationists' point of view, this age range is the one normally defined as comprising early years education, an area of study which requires more attention. Most notably it arises from the assumption that early learning is particularly important, being the foundation for all that comes later.

In choosing a biological concept for study the author maximises her background as a biologist and in choosing the age range four to eight years she draws upon her many years of experience in early years education. Therefore, although it draws heavily upon the psychological literature, this thesis is the work of an educationist and is intended to be of interest to those educators whose work is concerned with young children.

1.2 The theoretical background for the research

A major concern for science educators is the manifestation of pupils' misconceptions in science: the individual mental frameworks which are different from those held by scientists and which have been found to cause adolescent learners to misinterpret both the results of experiments and the explanations of teachers. A further difficulty for educators is that these alternative ideas appear to be long-standing and are difficult to change. So far, reference in the literature to the origins of these misconceptions has been made in only the most general terms. Early experiences, faulty or incomplete explanations offered by family members and friends, and misleading accounts in the media have been mentioned as possible sources. Alongside this concern is a growing accumulation of two apparently conflicting lines of evidence. On the one hand, young children demonstrate the acquisition of an impressive amount of accurate factual knowledge about the world and display very effective reasoning ability. On the other hand, they make knowledge statements which are different in kind to those of older learners and which appear to indicate both surprising ignorance and an alternative view of the world. There has, so far, been little attempt to relate these different empirical findings about young children with the persistent misconceptions of older learners. As a result, educators of young children are unaware of the ways in which they might be able to address the problem. The issues are without doubt complex but nevertheless deserve consideration.

1.3 The aim of the research

The aim of this research is to carry out a detailed study in young children of the development of just one concept in the hope that some apparently contradictory lines of evidence can be reconciled. This is done through searching for answers to two empirical questions. Firstly, it seeks to identify the changes that are evident in children's knowledge and understanding of the topic across the age range four to eight years. Secondly, it attempts to identify the sources of children's knowledge and understanding both in the school environment and elsewhere. In the interpretation of the empirical findings of the study, ideas from different branches of the developmental literature are employed in a way which has not been carried out previously.

1.4 The rationale for the research

The rationale for the research arises from a belief among science educators that knowledge and understanding develop through a process of personal construction. Contrary to the popular, uninformed view, this means that learning cannot take place by transmission from teacher to pupil, but must instead be constructed by each individual. Input from the outside world is subjected to mental actions by the learner, resulting in a unique construction of knowledge and understanding. This perspective on learning highlights the inappropriateness of the commonly used phrase 'teaching and learning' since learning is an individual process acting upon many different kinds of input. It is therefore impossible to assume a direct correlation between learning and teaching. Although there is some reference to teaching in this thesis the emphasis is upon learning.

1.5 The relevance of the research

The National Curriculum in England, produced by governmental agencies (e.g. Department of Education and Science, 1991; Department for Education and Employment and Qualifications and Curriculum Authority, 1999) identifies science as one of three core subjects, in company with language and mathematics. Its perceived importance arises from a widely held assumption that some understanding of the principles of science is an important component of education for citizens in the present technological age. Indeed, hardly a week elapses without reports in the media of controversial scientific issues upon which informed decisions should be taken. Furthermore, the subject is in its own right part of a balanced curriculum and in particular, it is advisable to lay sound foundations in those who will embark upon a scientific career. It is especially appealing for young children because it provides a natural outlet for their curiosity about the world and their desire for practical activity.

Although the teaching of science is now well established in early years classrooms little has been done to tease out the elements which contribute to the development of children's concepts or to integrate the recent findings of developmentalists. Those concerned with education in the early years would benefit from an explanatory account of how young children develop scientific concepts. It would be helpful for them to understand the reasons why some of the statements they make are unlike those of older learners, and to be aware of the origin of misconceptions. It is intended that this work will be of benefit to teachers, teacher trainers and others involved in early years education.

This work is an exploratory investigation of the development of one concept in a case study framework. Simple generalisation of the findings to other cases is not possible but they can none the less be of general interest to science educators. First, it is hoped that the design and methods of the study will be of interest to other researchers irrespective of the science topic, and that it may lead to replication and development. Second, it is hoped that teacher-trainers and others who influence teacher-training will find the subject and findings sufficiently important to give them greater attention than they seem to do at present. Thirdly, it is hoped that teachers themselves will be encouraged to change and develop their practice in response to these findings.

1.6 The originality of the research

The origin of food is a topic which is of interest to young children and one about which they can learn throughout the chosen age range of four to eight years. Unlike the development of some other scientific topics (for example electricity, which can be studied during the delivery of a few lessons), children have the opportunity to learn about the origin of food items in a variety of contexts, both in school and more informally elsewhere. Therefore the enquiry into children's opportunities for learning involves a study of both school and family-based environments.

The originality of this thesis lies not only in the results of the empirical enquiry but also in its engagement with recent work reported in the developmental literature in an explanation of these findings. Whereas there is already a rich educational literature concerning language development and some with respect to mathematical development, the development of science concepts in young children is an emergent field.

Studies of the development of science concepts in young children have been conducted by two groups of researchers trained in different disciplines: those in education and those in developmental psychology. Whereas educationists have been primarily concerned with a description of the ideas expressed by children at different ages, developmental psychologists have tested hypotheses about the theories children hold. Yet even developmental psychologists have not taken account of the full range of publications which identify developmental changes in young children. Much of this work is complex and is not readily fathomed by teachers. The present study is important because it integrates ideas from these two disciplines.

1.7 The operationalisation of the research questions

The research questions were resolved through a case study of children in two primary schools in the North East of England and their feeder nurseries. In these schools, as in other regions of England, science is taught in response to the directive of the National Curriculum.

A semi-structured interview approach was employed in order to discover children's knowledge of the origin of a number of common food items. Also included was a question designed to elucidate children's understanding that all food is derived ultimately from plants. These interviews were conducted with closely matched groups of thirty children at each age of four, six and eight years.

The opportunities for children to learn about the origin of food items presented a special challenge. With few exceptions, it was not possible to observe actual teaching sequences in the school context due to the incidental and therefore unpredictable nature of the subject matter. It was even more difficult to collect data about experiences in the context of home and family. In fact, literature with respect to learning outside the school context is sparse. Therefore an ethnographic approach was employed, so that data were gathered from a number of different sources. One of these involved a novel technique: a small group of volunteer parents kept diaries about their children's experiences over a period of three years.

The focus of the research is, then, upon the relationships among pupils' developing knowledge and understanding, their opportunities for learning and developmental explanations for the empirical data.

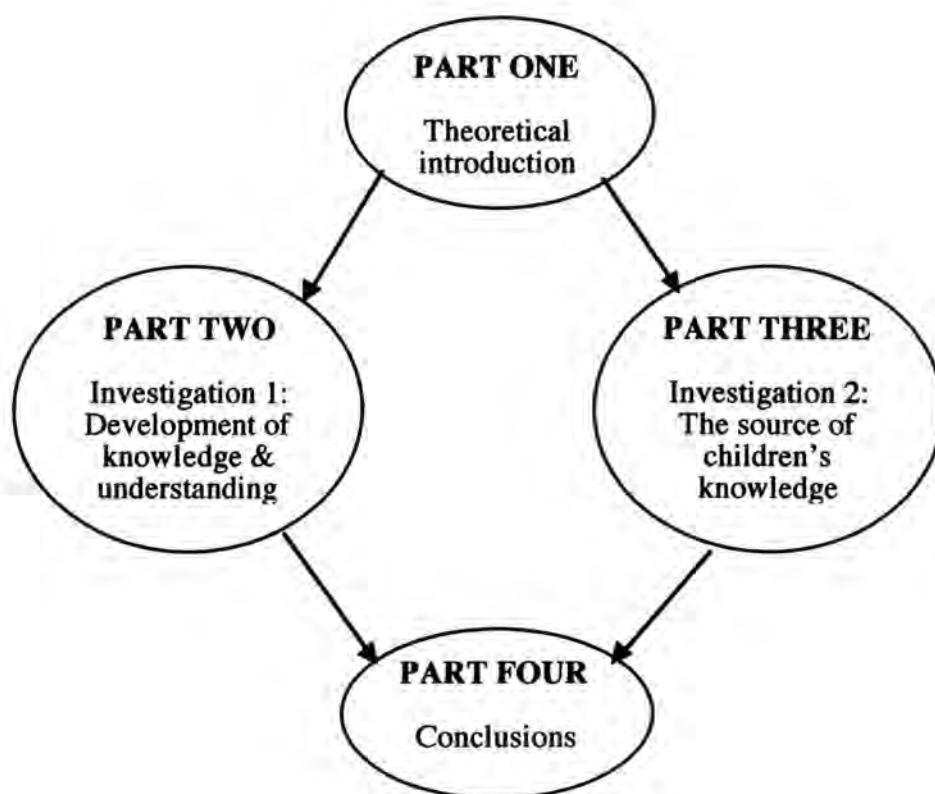
1.8 Overview of the thesis

The composition of the thesis reflects the different elements in the study as well as the relationships among them. It is divided into four parts. The first part sets the scene and provides a theoretical introduction to the work as a whole. The second and third parts deal with the empirical work. Finally, the fourth part concentrates upon the conclusions to be drawn. The way the four parts relate to each other is illustrated in figure 1.1.

Following this introduction to the thesis as a whole, the second chapter places the constructivist view of learning in science within the more general, empirical

accounts found in psychology and neuroscience. Then the thesis turns to the literature concerning the development of biological concepts in young children. Although this review therefore omits work on physics and chemistry and is limited to those studies which include children in the age range four to eight years, it addresses the major issues in science concept development identified in this introductory chapter. The work of developmental psychologists is reviewed in chapter three and the work of educationists in chapter four. Both are critiqued in the light of more general developmental principles. The first part of the thesis also includes a discussion of the methodological issues relating to work with young children.

Figure 1.1 The structure of the thesis



Of all the studies reviewed, not one traces the development of a single concept from the building up of individual items of factual knowledge through to understanding based upon that knowledge. Neither do they provide evidence of the experiences children have which might contribute to their knowledge and understanding. These questions are addressed in the second and third parts of the thesis.

The second part of the thesis deals with the collection, analysis and discussion of data relating to the development of children's knowledge and understanding of the organic origin of food.

The possible sources of this knowledge and understanding is the subject of the third part of the thesis. As an introduction to this section, a short chapter is devoted to a review of the literature concerning children's opportunities for learning outside school. Due to the meager contribution of science topics to this field of study some work on other areas of knowledge is included. Its purpose is to clarify what is already known both about the opportunities for learning children have in the context of home and family and about the methods employed. This research is evaluated in terms of its relevance to the present study. In the following two chapters there is an account of the collection, analysis and discussion of data relating to children's opportunities for learning about the organic origin of food both in the school context and elsewhere.

The final part of the thesis consists of one chapter. It is an attempt to draw together the different aspects of the research. Conclusions are drawn concerning the issues identified in this introduction. These are not only about the way factual knowledge is built up and its contribution to understanding but also the reasons why young children make statements which are different in kind from those normally given by older learners. It is posited that these statements may not indicate either limitation of knowledge or the presence of long-standing misconceptions. Yet at the same time, the first sign of a fundamental misconception might remain unnoticed.

This thesis has been identified as an exploration. Therefore it identifies ideas which might fruitfully be tested as well as more general areas for further study.

CHAPTER TWO

THE CONSTRUCTIVIST VIEW OF LEARNING IN SCIENCE

2.1 Introduction

Theories of learning have long been employed by educationists in their efforts to provide a coherent framework for teaching. However, many of these theories have been criticised both for their poor relationship with empirical evidence and for their lack of relevance to classroom practice.

In science education the predominant theory of learning is constructivism. Its importance was first noted in the science education literature (Driver 1983; Driver, Guesne and Tiberghien 1985) when it was utilized in the explanation of misconceptions in adolescents.

Constructivism was also employed in the formulation of an approach to teaching in science. It was hoped in this way to overcome the problems caused by pupils' misconceptions. Despite these efforts, recent work has demonstrated that scientific misconceptions are highly resistant to change, even when using a constructivist approach. This disappointing result has led researchers to question the usefulness of constructivism as a theory of learning in science (Solomon 1993a, 1994a; Osborne 1996), although as yet no better theory has been forthcoming.

The aim of this chapter is to evaluate constructivism as a theory both in relation to learning and to teaching science in terms of more general empirical studies in cognition.

2.2 Outline

At the beginning of the chapter there is a brief overview of the evolution of beliefs about the nature of science and how it is learned. Following this, the concerns of educationists are highlighted in a description of constructivism as a theory of learning and how it is related to approaches for teaching. Then the two identified aspects of learning in science, both empirical observations and theoretical explanations, are examined in turn. Some empirical evidence from cognitive psychology is brought into focus in an attempt to elucidate the processes at work in the construction of knowledge from sensory perception. Next, the socio-cultural aspect of learning is examined from a constructivist perspective: how a child learns

from others. In relation to science, a pupil must learn how to carry out practical investigations as well as coming to an understanding of the theoretical aspects of the subject. In conclusion, recommendations are made for the status of constructivism as a theory.

2.3 The evolution of beliefs about the nature of science and how it is learned

Insight into the nature of science as a subject must influence a teacher's perspective on how it is learned. Traditionally, science was viewed as a collection of objective facts about the material world. From this viewpoint the main emphasis in learning the subject was upon memorising the factual material produced by others. Thus, "the style of science teaching [was] largely formal, based on teaching definitions and derivations and on experiments which illustrated forgone conclusions" (Black and Lucas 1993: 4). At the heart of this belief was a transmission approach to teaching, as the pupils were presumed to receive the knowledge conveyed to them by the teacher.

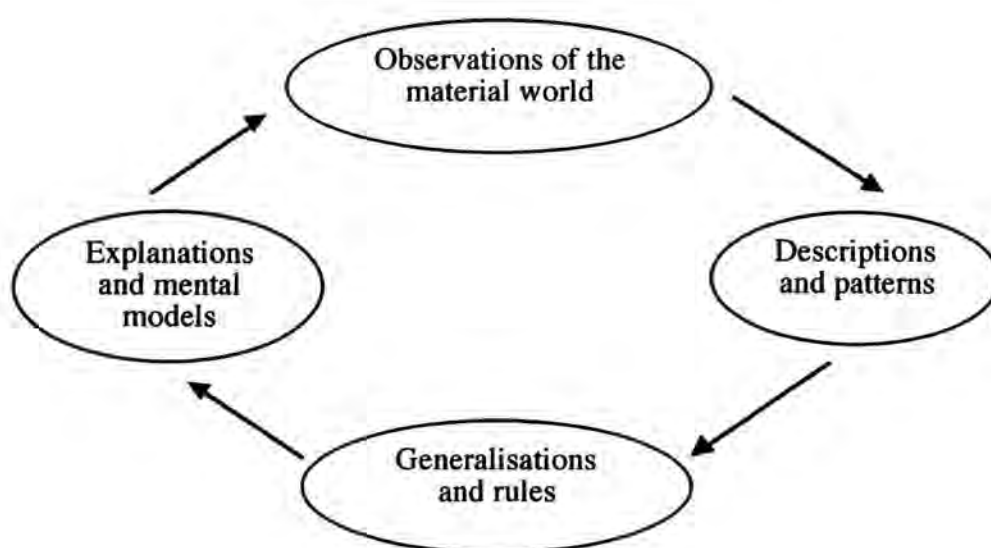
By the second half of the twentieth century the importance of the processes of science was recognised. As a result of this insight it was believed that a more active engagement with the material world through direct observation and guided experimentation would allow learners to discover the scientific facts for themselves. Accordingly, Hodson (1993: 15) argues that "the only effective way to learn to do science is by doing science alongside a skilled and experienced practitioner who can provide on-the-job support, criticism and advice".

At the time of writing this thesis the view of science as a subject has changed once more. In recognition of human agency in the formulation of knowledge, Driver and her colleagues state that "The central aim of science is to provide explanations for natural phenomena" (Driver, Leach, Millar and Scott 1996: 26). In this view, both theoretical knowledge and practical skills are recognised as equally important in a subject which is seen to be the product of human enterprise rather than objective truth. Pushed to its limits this recognition of science as a social activity places its knowledge claims in the sphere of human construction rather than objective reality: "Rather than seeing science as an endeavour to establish claims about a world which exists independently of the knower, ... a post-modernist perspective adopts a view of local knowledges being established within particular situations or standpoints" (Driver, Leach, Millar and Scott 1996: 41).

In seeking to clarify the relationship between theory and empirical investigation, Driver and her colleagues (1996: 43) suggest that “scientific enquiry involves the collection and use of data (evidence). This may be used to provide the ‘raw material’ which an explanation has to account for; or to test proposed explanations.”

This notion of scientific knowledge as a human construct is explained by Sizmur and Ashby (1997: 3) as taking “the form of systems of concepts and theories. It is, in effect, a *language* for describing what reality consists of and how it operates”. Observations of the material world, the identification of patterns, the formulation of generalisations and rules and the development of scientific explanations and mental models are components in this construction of scientific concepts and theories. The relationship among them is illustrated in figure 2.1.

Fig 2.1 The construction of scientific concepts and theories



If scientific knowledge is developed in this way then students will need assistance from the scientific community in order to apprehend it. This is because “scientific entities and ideas, which are constructed, validated and communicated through the cultural institutions of science, are unlikely to be discovered by individuals through their own empirical enquiry” (Driver, Asoko, Leach and Scott 1995: 2).

Just as science knowledge is seen as a human construct, so the process of learning science must be regarded as a personal construction. Implied in this is the idea that new learning builds upon what has gone before. Mintzes and Wandersee (1997a: 47) argue that “individuals construct meanings by forming connections between new concepts and those that are part of an existing framework of prior knowledge,” thus emphasising that learning cannot be a product which is faithfully conveyed by teachers to pupils. Instead, they describe personal knowledge as “an idiosyncratic, dynamic construction of human beings” (Mintzes and Wandersee 1997a: 50).

Implied in this description of learning is the belief that meaning must be constructed from a collection of factual items: “structured knowledge ... is not just a consequence of the amount of information received, but reflects exposure to an environment for learning” notes Glaser (1996: 106). He suggests that problem solving, analogy making, extended inferencing, interpretation and working in unfamiliar environments requiring transfer, are all activities which support meaningful learning. From this structured knowledge it is possible to develop deep understanding, which can be seen as a function of a rich, integrated network of well-structured information: “In science, understanding is the connecting of facts, the relating of newly acquired information to what is already known, the weaving of bits of knowledge into an integrated and cohesive whole” Newton and Newton (2000: 599)

To be sure, good teachers have always listened to their pupils and shown an interest in their ideas. They have tried to relate new material to what is already known and have acknowledged the personal effort required for learners to make progress. But simple acknowledgement that pupils have to construct their own knowledge is only a trivial stance. von Glasersfeld holds a much stronger position which he terms radical constructivism. Believing that “reality lies beyond all knowing” (von Glasersfeld 1998: 24), his point of view is diametrically opposed to the idea that linguistic communication is a means of conveying knowledge. Moreover, he maintains that it is not possible to verify whether the meaning which is associated by a given person to a particular word is absolutely the same as the meaning the speaker associated with it. In commenting upon scientific knowledge, he notes that whenever several solutions have been found to scientific problems, one of them may be preferred over others for reasons of economy, simplicity, or ‘elegance’, but not because it is ‘true’. Instead of truth, therefore, radical constructivism speaks of viability and compatibility with previously constructed models of the world.

2.4 The limitations of constructivism

Echoing earlier work, (for example Driver, 1983), Mintzes and Wandersee (1997b: 75) acknowledge that “learners develop a set of well-defined ideas about natural objects and events even before they arrive at the classroom door”. In fact, far from ascertaining scientifically correct concepts and theories through personal discovery, “observing the world ... allows children to develop theories of their own that have a poor match to those of the scientist” (Sizmur and Ashby 1997: 4). These ideas serve a useful function in everyday life and pupils cling to them, resisting the efforts of “even our finest teachers and most thoughtful textbook authors and curriculum developers” (Mintzes and Wandersee 1997b: 75). Moreover, the alternative ideas (or misconceptions, from the scientists’ point of view) formed in this way are not simply held alongside those presented in the classroom, they can actually interfere with sound learning in science. This is because they “often react with knowledge presented in formal science lessons resulting in a diverse set of unintended learning outcomes” Mintzes and Wandersee (1997b: 75). According to Mintzes and Wandersee (1997a: 52) constructivist approaches to teaching include “the creation and resolution of conceptual conflict”, in order to help students acknowledge their misconceptions and develop ideas more in accord with the full range of empirical evidence.

Despite all these efforts, however, “the learning outcomes which follow instruction are often disappointing in terms of how much students understand; how much they are able to apply; and how much they are able to remember” argue Leach and Scott (2000: 44). This finding has stimulated a reappraisal of constructivism. Its strength as a theory of learning is the way “it described, in new language and associated metaphors, the alternative ideas and meanings that many pupils hold,” notes Solomon (1994a: 16). What is more, it is conceded that for teaching:

What constructivism does have to offer is a useful focus on the learner as an active participant in the learning process, a range of pedagogic practices which encourage the child to be active, and a body of empirical research findings which are invaluable for sensitising teachers to the forms of scientific thought that children hold and their possible stages of development.

(Osborne 1996: 68).

Nevertheless, both of these authors maintain that a weakness in pedagogy which has arisen from constructivist theory is the emphasis it places upon the individual learner. Therefore in contradiction of the idea of personal construction of knowledge, Osborne (1996: 54) argues that “constructivist pedagogy often makes a

fallacious connection between the manner in which new scientific knowledge is created and the manner in which existing scientific knowledge is learned". Instead, Solomon makes a case for the idea that learners should be introduced to science through a process of enculturation, because "what constructivism has *not* described is the process of learning as arrival on a foreign shore, or as struggling with conversation in an unknown language" (Solomon 1994a: 16). Osborne indicates further limitations of constructivism in his identification of a number of omissions. He contends that "there is a failure to use the theory ... to predict or discuss what it might imply for the content and process of science education and to derive any detailed propositions which could in principle be empirically tested" (Osborne 1996: 64). He censures the promotion of interventions that have predominantly focused on conceptual conflict, because these have shown only limited effectiveness. Further, he reasons that constructivism provides "no well-defined mechanism by which the individual can develop new constructs with which to see the world" (Osborne 1996: 65). Despite this, his own proposals for teaching focus on a subject-oriented use of analogy and metaphor and offer no fresh insight on pupil progress and the nature of learning.

According to Solomon (1993a: 14), "the misconception frame struggles to teach better and may need help from some distanced explanatory theory", since the mere cataloguing of children's developing ideas has proved inadequate. In order to make progress, "the pressing need is for some clues as to the dynamics of conceptual change" notes Russell (1993: 83), who suggests that other disciplines, such as applied cognitive developmental psychology may provide the necessary insight. This recognition of the need for greater developmental insight is gaining support from educators in general, as "the study of learning, including learning in babies and young children, is not only an essential strand of educational research but one likely to yield important findings in future work" (Mortimore 2000: 11).

However, according to Lucas (1993), better use could be made of the knowledge which is already available, because "what we already know - fragmentary, messy, and inconclusive as it is - will enable us to ask questions about the role of prior knowledge that treat 'knowledge' much more broadly than has been done to date in constructivist accounts of learning science" (Lucas 1993: 146). Therefore: "The central concern of future work must be with a theory of learners and learning which might be adequate to interpret and guide research" (Black and Lucas 1993: 230).

Notwithstanding such comments, a more coherent account of how pupils develop concepts in science has not been forthcoming. In fact, Leach and Scott (2000) have

turned away from this focus upon children and their ideas to the content of what is to be taught. They suggest instead that teachers should analyse science knowledge in terms of learning demand upon pupils because “the concept of learning demand helps focus the teacher’s attention on the personal steps required for sense-making in the learning of science, and further, provides a starting point for identifying the nature of any difficulties which the learner is likely to experience in coming to accept the scientific point of view” (Leach and Scott 2000: 44). Leach and Scott (2000: 77) do acknowledge the importance of both the practical and cultural aspects of learning in science, noting that “basically there are two sources of human learning - knowledge that is acquired through sensorimotor interaction, that is, by acting and intervening on the world, and knowledge that is acquired through cultural transmission”. Nevertheless, in these views on pedagogy they appear to have turned to the more traditional idea of knowledge as transmitted from teacher to learner, albeit with the help of practical illustration.

Notwithstanding this recent trend, it is the contention of this thesis that there exists in the psychological literature a good deal of information about learning which supports constructivist theory. Despite its complexity, this literature is relevant to an understanding of the development of concepts in science. However, more could be done to make the information available to educationists. It is proposed that the first task is to begin with the youngest age group in working towards a coherent account of the development of concepts in science across the school age range. In the two sections which follow there is an attempt to tease out from the psychological literature the empirical support for constructivism. In pursuance of the two sources of learning already mentioned by Leach and Scott, the first examines evidence in support of a personal construction of knowledge from sensory experience and the second examines evidence for a personal construction of knowledge through cultural mediation.

2.5 Constructing knowledge through the senses

Practical experience of the material world forms a necessary base for pupils upon which to build an understanding of the formulations of scientists. In this section an overview of evidence from cognitive psychology is presented in confirmation of the idea that each individual constructs personal knowledge by processing sensory experience. However, a problematic aspect of learning through the senses is its intentionality. As well as this, the means by which sensory knowledge becomes available for explanation by the knower (that is, how it becomes translated into speech), is open to question. Thus although it is easy to observe that much

knowledge based on sensory perception is constructed through a conscious and deliberate process, there is also empirical support for the idea that a good deal of such learning takes place without conscious deliberation. As well as this, there is support for the view that the transformation between implicit and explicit knowledge is a two-way process.

2.5.1 The personal nature of sensory knowledge construction

There is overwhelming empirical evidence from animals including humans, that the physical basis for learning is to be found in the brain, with its vast network of interconnected nerve cells. For example, through a series of experiments Rose (1992) demonstrated that young chicks can learn that a coloured bead tastes bitter, and remember it for several days. An examination of the brains of the chicks revealed that in the hours following the learning experience a cascade of chemical changes had taken place in defined regions of the brain. There is empirical evidence on a cellular level as well. Each neurone (nerve cell) has many long, thin extensions, the dendritic branches, linking it to other neurones. Messages in the form of tiny electrical impulses can pass from one neurone to the next across the synaptic junctions. Rose demonstrated that new synaptic connections are formed in the chick's brain as a result of learning.

Notwithstanding the fact that every individual's experiences are similar to those of their neighbours, it would be a mistake to think that they all share exactly the same knowledge. This is illuminated by the cognitive psychologists Gazzaniga, Ivry and Mangun (1998), who explain that:

we do not directly perceive and act in the world. Rather, our perceptions, thoughts, and actions depend on internal transformations or computations. Information is obtained by our sense organs, but our ability to comprehend the information, to recognise it as something we have experienced before, and to choose an appropriate response depends on a complex interplay of processes.

(Gazzaniga, Ivry and Mangun 1998: 93)

In this quotation Gazzaniga and his colleagues identify two key ideas which underpin the notion of individual knowledge construction. The first is the generally accepted one that sensory information is sorted and classified to produce a personal mental 'picture' within the brain. The second idea, which supports a belief in construction, is that the memory of earlier experiences may influence what aspects of a sensory stimulus are attended to, how the new information is interpreted, and how it is remembered.

In confirmation of the first idea (that sensory information has to undergo a process of personal processing), Dawson (1998) describes the example of an aspect of vision: the phenomenon of the apparent motion perceived from a succession of static images, as happens when 'moving' films are watched. However, information processing is not simply a sequential process from sensation to perception to memory through linking synapses. The second idea, that aspects of a sensory stimulus are all subject to a personal filtering system, is illustrated by McEwen and Sapolsky (1995). These researchers conducted a number of empirical studies which demonstrate that variables such as the context in which information is delivered, prior experiences, and emotional state at the time, all affect the way in which information is retained and the accuracy with which that retention occurs. In illustrating the last point, they cite the well-known example that those who were alive at the time can recall where they were when hearing that John F. Kennedy had been assassinated. Whereas few can recall any preceding events from that day, it was the emotional charge of the news which caused memorisation of details surrounding the announcement.

2.5.2 The formation of concepts

The classification of objects and events into categories is a necessary prerequisite in the formation of concepts. Neisser (1987: 1) defines categorisation as the ability "to treat a set of things as somehow equivalent, to put them in the same pile, or call them by the same name, or respond to them in the same way". Stevenson (1993: 182) notes that "by grouping things together into a single category we are able to make sense of the world and carve it into manageable chunks". Not only does categorisation greatly reduce the amount of information that must be processed, it also promotes further knowledge because it "allows us to draw inferences about imperceptible properties, (for example, 'if it's a dog, then it may bark when provoked')". explain Smith and Jonides (2000: 1013). Just as computer files are subjected to an hierarchical arrangement of folders for ease of storage and retrieval, so the information stored in memory is sorted and grouped into mental structures. Nevertheless, unlike a computer filing system, there is within the brain a network of interconnections among the units of information so that the same objects and events can be sorted in different ways at the same time.

2.5.3 The construction of knowledge without conscious intent

It is clear that much early learning about the material world is deliberate and systematic, a result of the innate compulsion to learn which is evident in young children. For example, Driver (1983: 2) notes that “the baby lets go of a rattle and it falls to the ground; it does it again and the pattern repeats itself”. She argues that this is just one example of informal learning about the world: “as the child grows older, all its experiences ... stimulate the development of more generalised sets of expectations and the ability to make predictions about a progressively wider range of experiences” (Driver 1983: 2).

In accounts such as these, little attention is paid to any unintentional or implicit learning which might take place. After all, it is not obvious to observers. Therefore, even when children’s ideas are described as informal or intuitive, no distinction is drawn between the implicit or nondeclarative knowledge gained in this way and the explicit knowledge gained by intentional means. In fact, it is generally assumed that implicit knowledge can only be detected through a person’s behaviour and cannot be put into words at all. However, it is explained below that unintentional or implicit learning can become translated into explicit form through a process of Representational Redescription (Karmiloff-Smith, 1992). It follows that the importance of implicit learning should not be underrated. Indeed, the idea is an important component of this thesis.

To begin with, it is necessary to explain the nature of implicit learning. There is empirical evidence that sensory information taken in by animals from their surroundings is sorted and stored in the brain; all without conscious, deliberate thought. For example, in his description of learning about a bitter bead in a young chick (mentioned above), Rose (1992) provides evidence of a classification process at work. In a series of experiments he discovered that memories of the colour, size and shape of the bead, the time of day and the orientation in which it was presented were each found to be stored in a different brain region. According to Rose, what was seen and experienced was subjected to an automatic sorting process. “When the chick has learned about the bead, any one of these cues will subsequently allow it to avoid it” (Rose 1992: 287). “The ability to detect, register and make use of the patterns of relationships that happen to characterise your particular environment is widespread in the animal world” notes Claxton (1997: 18).

Humans undergo implicit learning as well. Ericson, Jagadeesh and Desimone (2000: 745) found that objects are selected from scenes even when we are not actively

searching for them and have no prior expectation that they are present. That learning can take place as a result is explained by Posner and Digioirolamo (2000: 623), who argue that "it is clear that unattended information is often processed to a high level, as evidenced by the fact that an important message on the unattended channel can interfere with the selected channel". Furthermore, when humans acquire knowledge in this way "a person learns about the structure of a fairly complex environment without necessarily intending to do so, in such a way that the resulting knowledge is difficult to express" (Berry and Dienes 1993: 2). This is implicit learning. Furthermore, "Implicitly acquired knowledge is responsible for performance that goes beyond what estimates of conscious knowledge would predict" (Reber 1993: 47).

In an account of implicit learning and its consequences it is necessary to differentiate between implicit *learning* and implicit *knowledge*. Implicit *knowledge* simply means knowledge which is not easily accessible to consciousness or cannot readily be communicated on demand. However, the idea of implicit knowledge is complicated by the fact that knowledge gained in a conscious and intentional way can become implicit with practice. For example, when a person takes driving lessons the process is explained in detail, but the learner must practise until the actions become automatic. An experienced driver can then exercise control of a car without taking time to think. The explicit knowledge has become implicit.

On the other hand, implicit *learning* refers to the way in which knowledge is acquired. "No conscious intention, no deliberation, no articulation is needed to fulfil this brilliant function. Knowing, at root, is implicit, practical, intuitive," declares Claxton (1997: 9), who believes that "the greater part of the useful understanding we acquire throughout life is not explicit knowledge, but implicit know-how" (Claxton 1997: 20). This consequential and lifelong view of implicit learning contrasts with the theorising of Piaget, who in his stages of cognitive development (see chapter three), indicates that early intuitive learning is superseded by intentional processes.

Knowledge which is gained implicitly has both sources and properties which distinguish it from knowledge gained through explicit means. Firstly, Squire and Zola (1996) delineate different origins for the two forms of learning. Whereas explicit learning emanates from facts and events, implicit learning is derived from procedures, emotional responses, non-associative sources and skeletal musculature. Secondly, Berry and Dienes (1993: 13) identify a number of characteristics which establish the functional independence of implicitly learned knowledge, two of which

will be mentioned later in the thesis. They are that implicitly acquired knowledge engenders a sense of intuition and is resistant to disruption or decay.

Recognition of implicit learning does not deny constructivism. But it does mean that some knowledge, especially knowledge acquired in informal settings, is not deliberately constructed, does not require conscious effort and that the holder is unaware of its presence. What is more, there are implications for teachers in recognition of implicit learning, for as claimed by Cumming (1998), it provides two reasons why some misconceptions in science are so resistant to change. The first is that implicit knowledge in its simplest form is notably resistant to disruption or decay. The second is that it engenders a sense of intuition; an inner conviction that the knowledge is true.

2.5.4 The translation of sensory knowledge into language

What is not clear from the above description of learning through the senses is the point at which a learner can express such knowledge in words. This is the case whether the learning was intentional or unintentional. In fact, it is clear that each individual has a good deal of knowledge about forces (pushes and pulls) which is never expressed in language. For example, an infant learns to walk and to feed itself, two processes involving complex sequences of muscular contractions, predictions and responses to feedback, well before it has learned to speak. At no time in their lives is such knowledge explained by the majority of people.

On the other hand, informal knowledge gained through the senses about forces comes to light in science lessons:

... as the child grows older, all its experiences of pushing, pulling, lifting, throwing, feeling and seeing stimulate the ability to make predictions about a progressively wider range of experiences. By the time the child receives formal teaching in science it has already constructed a set of beliefs about a range of natural phenomena. In some cases, these beliefs or intuitions are strongly held and may differ from the accepted theories which science teaching aims to communicate.

(Driver 1983: 2)

2.5.4.1 Karmiloff-Smith's model of Representational Redescription

By no means all sensory learning is implicit or unintentional, but however it is acquired much is initially unavailable to language. Karmiloff-Smith's Representational Re-description theory offers a mechanism for the way in which

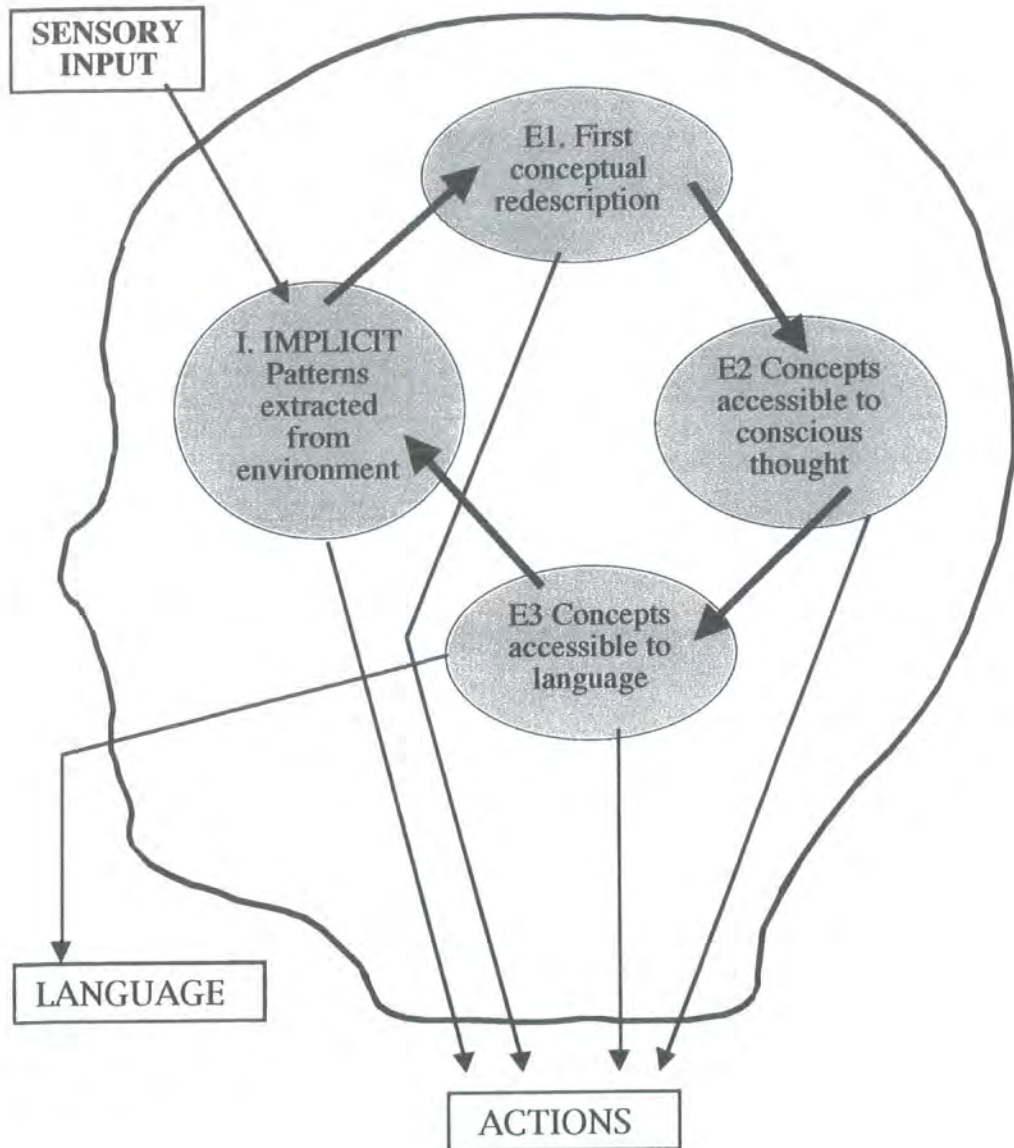
knowledge gained through the senses can be transformed into explicit, linguistic form. Indeed, “no one else ... has presented as detailed, plausible, empirically-grounded, and potentially fruitful a model of how implicit understanding becomes explicit and conscious” (Estes 1994: 716). This theory rests upon the idea that “a specifically human way to gain knowledge is for the mind to exploit internally the information that it has already stored, by re-describing its representations ... in different representational formats” (Karmiloff-Smith 1992: 15). So sensory information that is processed automatically to produce implicit knowledge can be re-described through different levels of thought until it reaches conscious awareness. In other words, mental representations “not necessarily available to conscious access and verbal report ... can be re-coded into consciously accessible representations” (Karmiloff-Smith 1992: 22). Figure 2.2 illustrates her model of Representational Redescription.

The process of Representational Redescription is not seen as instantaneous. Indeed, the “notion of representational change over time will be my focus throughout this book” claims Karmiloff-Smith (1992: 27). However, she allows an exception in the case of the notational domain, where children may express their knowledge in the form of drawings. Karmiloff-Smith (1992: 148) describes this as “microdevelopmental change, that is change that occurs within the confines of an experimental situation”.

In Karmiloff-Smith’s model, knowledge appears to move in the opposite direction to that seen in the development of expertise where conscious, explicit knowledge becomes automatic and implicit through practice. She resolves this apparent contradiction by suggesting two complementary directions in the movement of knowledge. On the one hand, there is the “gradual process of proceduralisation, rendering behaviour more automatic and less accessible”; and on the other, there is a process of “explicitation and increasing (conscious) accessibility” (Karmiloff-Smith 1992: 17).

Karmiloff-Smith’s (1992) work constitutes a response to Fodor’s (1983) book, *The Modularity of Mind*. Aspects of their ideas about mental modularity are discussed in chapter three.

Figure 2.2 Illustration of Representational Redescription



2.5.3.2 Discussion of Karmiloff-Smith's model

Several workers have been critical of Karmiloff-Smith's model. They refer in particular to the precision of her definition of implicit knowledge and to the representation of that knowledge. Bodor and Pleh (1994), for example, suggest that some of her key notions are not entirely clear. They mention the concept of implicit knowledge: "from the start on, this sometimes seems to be interpreted in a literal, propositional way; at other times as any kind of disposition" (Bodor and Pleh 1994:

709). They also believe that the term ‘behavioural mastery,’ used for the I level, is masking the issue of whether it is a ‘knowing how’ type of knowledge or a propositionally organised ‘knowing that’. On the other hand, Campbell argues that Karmiloff-Smith’s account of the transition from E1 to E2 to E3 “ought to supplant the customary sloppy discourse about ‘implicit’ and ‘explicit’ knowledge” (Campbell 1994: 711). Karmiloff-Smith herself (1994) believes that “what [Representational Redescription] tries to show is that there are multiple levels of ‘knowing that’, [as opposed to ‘knowing how’] which a simple dichotomy does not capture” (Karmiloff-Smith 1994: 736).

According to Vintger and Perruchet (1994), knowledge gained by implicit means may not have the structure evidenced in formal knowledge. They refer to a growing set of data which shows that “early adaptive changes are not due to the acquisition of an implicit knowledge base representative of the actual structure of the situation” (Vintger and Perruchet 1994: 731). They propose instead that the initial improved performance observed is due to some kind of direct sensitivity to the product of the rules and not to the implicit encoding of the rules themselves. Scholnick (1994) concurs, noting that “even in structured domains, the structure is often underspecified” Scholnick (1994: 728).

A further limitation of Karmiloff-Smith’s model is noted by Carassa and Tirassa (1994), who suggest that it seems to deal with how knowledge contents are used, rather than how they are actually represented in the system: “it resides at the knowledge level rather than on the symbol level” (Carassa and Tirassa 1994: 712). Notwithstanding these criticisms, Carassa and Tirassa acknowledge that “the psychological evidence it brings is impressive, and the plausibility of the model is not impaired by our considerations; but much work will be needed to answer questions about the architecture of an RR system” (Carassa and Tirassa 1994: 712).

2.5.3.3 Karmiloff-Smith’s model and metacognition

Certainly, there is evidence that people can manipulate knowledge which has not quite reached linguistic form. For example, Karmiloff-Smith (1994) notes that children sometimes use knowledge they can only display in gesture when deciding on the response to a question. She also remarks that adults can often draw diagrams of problems they cannot verbalise (Karmiloff-Smith 1992). A further complication is that it seems “linguistic knowledge does not constrain non-linguistic knowledge until both have been re-described into a similar format” (Karmiloff-Smith 1992: 22).

Once knowledge has reached conscious awareness, however, it is available for deliberate manipulation. For example, Donald (1994: 714) notes that in contrast to our nearest relatives, “humans voluntarily call up items from their own memory banks, reflect on them, alter them, and store the products of their own reflection”. Thus people can “undertake explicit theory change, which involves conscious construction and exploration of analogies, and thought experiments as well as real experiments” (Karmiloff-Smith 1992: 16).

Karmiloff-Smith rightly conceives of a continuum between implicit and explicit knowing, argues Kuhn (1994: 722), who believes that “a major aspect of development is the gradual ‘explicitation’ of knowledge”. Still, she is disappointed that Karmiloff-Smith “does not stress the critical development from thinking *with* one’s theories to thinking *about* these theories” (Kuhn 1994: 722). As she stresses, “the increased cognitive power this advance entails is hard to overstate. Only with this metacognitive advance are we in a position to know what we think, to exercise control over what we believe and why” (Kuhn 1994: 722).

2.6 The socio-cultural aspect of the construction of knowledge

According to Scholnick (1994: 728), “the role of culture and social experience as a source of knowledge is underemphasised” in Karmiloff-Smith’s model of Representational Redescription. Bodor and Pleh concur, noting that knowledge develops through transactions with other individuals. “It would be interesting to see how Representational Redescription deals with domains that seem to be driven from top down, (creating an I level from E level representations), and how it would deal with social constructivism,” they say (Bodor and Pleh 1994: 710).

Therefore, whereas the accounts of learning described so far in this chapter focus upon processes which take place within the individual child, socio-cultural models of learning describe the development of knowledge and understanding as an interaction between the learner and other individuals. Within these models it is recognised that humans are highly social organisms. Indeed, interpersonal interaction is seen as essential in children’s development. “Rather than viewing children as developing spontaneously, ... human development is channeled along specific courses by the socio-cultural activities of individuals and their social partners” (John-Steiner 1985: 190). Furthermore, for Light and Littleton (1999: 91) both “cognitive development and learning are fundamentally social processes”. However, even though the emphasis in this part of the chapter is on the part played

by interpersonal interaction, knowledge is still seen as the product of construction by individual learners.

In the first part of this section it is argued that interpersonal communication begins in early infancy. Then an overview of general ideas about the social construction of knowledge is presented. After this, the focus is upon the particular case of learning in science.

2.6.1 The development of interpersonal communication

An early exponent of socio-cultural learning is Vygotsky, whose main interest is in the development of language. In opposition to the idea described above (that knowledge begins with sensory perception), Vygotsky believes that thinking first appears on the interpersonal plane before becoming internalised through language.

Certainly, there is evidence that interpersonal communication begins early in life. For example, Meltzoff and Moore (1983) demonstrated that new-born infants can imitate gestures such as tongue protrusion and mouth opening after watching an adult. In their study, imitation was seen as an early stage in the development of communication, where each party to a dialogue took turns with the other. The next stage began when an infant gazed into the eyes of a caregiver and made babbling noises in response to the caregiver's talk.

According to Rogoff (1990: 65), interpersonal communication begins well before the acquisition of fluent speech: "babies communicate with adults and take turns at communicating in 'conversations' from a few weeks old". Then, after turn-taking without words comes shared attention: the caregiver begins to tutor the baby in things they can do together. In this way knowledge of what can be done, and how to do it, can be shared with the child. At first, this co-operation is achieved without language, but later it is common for an adult to give a verbal commentary on the activity. Clarification offered through the use of language in this way helps the child to understand aspects of the task that otherwise might have gone unnoticed.

2.6.2 General ideas about the social construction of knowledge

Wood, Bruner and Ross (1976) use the metaphor of scaffolding to explain how an adult creates simplified sequences of actions in which the child can participate until able to carry out a task unaided. The inter-relatedness of the roles of children and adults during scaffolding can be described as a process of guided participation.

According to Rogoff (1991), the strategies of infants appear similar to those appropriate for anyone learning in an unfamiliar culture: “[they] stay near a trusted guide, watch the guide’s activities and get involved when possible, and attend to any instruction the guide provides” (Rogoff 1991: 68-9). She notes that young learners often need more than one opportunity to work out the adult’s meaning. Therefore, “an important aspect of scaffolding involves providing sufficient redundancy in messages so that if a child does not understand one aspect of the communication, other forms are available to make the meaning clear” (Rogoff 1991: 79). Also, she observes that adults adapt their speech and gestures in order to help young learners: “caregivers simplify their own language, repeat and expand upon infants’ contributions, and provide visual supports to assist infants’ understanding” (Rogoff 1991: 80). Even so, the initiative for learning does not lie exclusively with adults. Children themselves are very active in learning during a scaffolding sequence, especially in informal settings, “directing adults towards desirable activities or away from undesirable ones” (Rogoff 1991: 77).

It would be a mistake to think that socio-cultural learning takes place only through direct interactions. According to Goswami (1998), language development itself plays a part in the formation of concepts:

Learning new words apparently teaches children about conceptual relations between objects and classes of objects. For example, the use of a common label in natural language such as *animal* for multiple referents such as horse, dog and fish acts in itself to classify them as members of the same superordinate class.

(Goswami 1998: 85)

This very act of classification is a way of increasing knowledge: “Recognising novel objects or events as familiar because they belong to a known category enables us to know more about those objects or events than is possible just from looking” (Goswami 1998: 74).

To be sure, children can also construct their own knowledge from secondary sources: the language and images presented by the media.

2.6.3 Interpersonal communication in school settings

Scaffolding is most often associated in the literature with informal learning situations rather than formal, institution-based teaching. Be that as it may, in a school setting scaffolding can provide support for formal learning. Echoing the description of knowledge construction described earlier in this chapter, it is

portrayed as a process “where adults help young children find the connections between what they already know and what is necessary to handle a new situation” (Rogoff 1991: 73). In contrast to the traditional, didactic approach to teaching, Rogoff explains that when taking a scaffolding approach in school settings adults can model mature performance during joint participation in activities.

Tharp and Gallimore (1988: 33-8), describe four stages of development in the process of scaffolding. At first, performance is assisted by more capable others. Next, the child takes over responsibility for the task and repeats the performance through practice. Then the child’s performance becomes internalised and automatic. Finally, the individual is able to evaluate personal performance in a conscious and deliberate way. Unlike Rogoff, however, they include the provision of directions as well as behaviour modelling in their description of scaffolding.

Scaffolding can be operative in learners of all ages, of course. For example, in a study of the career development of prominent and creative thinkers, John-Steiner (1985) proposes that development of a specific *language of thought* can be fostered more by interacting with a knowledgeable person than by studying books or attending classes and exhibits. Apprenticeship thus provides the beginner with access both to the overt aspects of the skill and the more hidden inner processes of thought. “It is only through close collaborations that the novice is likely to learn what the mentor may not even know: how he or she formulates a question or starts a new project” (John-Steiner 1985: 200). Nor is the gain all one-sided, for “more skilled partners often gain understanding of the process they attempt to facilitate” (John-Steiner 1985: 205).

One of the strengths of scaffolding is the opportunity for feedback it offers the learner. Referring to school settings, Gipps (1994) describes feedback as important for two reasons. Firstly, it contributes directly to progress in learning through the process of formative assessment which provides structure for future learning. Secondly, it contributes to progress indirectly through its effect on pupils’ academic self-esteem. Thus, through feedback the teacher provides “extension to the cognitive structuring and skill development arising from the child’s own initial experiences.” (Gipps 1994: 131). Constructive advice is a crucial component because “for optimal learning; [feedback] must indicate what the pupil can do to improve performance” argues Gipps (1994: 131). In fact, Black and Harrison (2000) mention twenty studies over the previous fifteen years which describe how the effects of formative assessment have been tested by quantitative experimental-control comparisons. All of these studies, which involve all ages (from five-year-olds through to university

undergraduates), across several school subjects, and over several countries show that the introduction of formative assessment results in significant learning gains. Another important feature of formative assessment was demonstrated by several of these studies, that “improved formative assessment helps the ‘low achievers’, and also pupils with learning disabilities, more than the rest, and so reduces the spread of attainment while also raising it overall” (Black and Harrison (2000: 26).

The idea of the Zone of Proximal Development is crucial in Vygotsky’s work on the socio-cultural approach to learning. Davydov and Zinchenko (1993: 102) explain that “at any particular stage of development a child can resolve a certain range of problems only under the guidance of adults and in collaboration with more intelligent comrades, but cannot do so independently”. This limited range of problems constitutes the Zone of Proximal Development: the optimal location for intervention in an individual’s learning. It is therefore vital for the adult to be aware of the child’s Zone of Proximal Development, since “sensitive and accurate assistance that challenges but does not dismay the learner cannot be achieved in the absence of information” (Tharp and Gallimore 1988: 41-2).

As learners become more proficient they are able to engage in an inner dialogue with their *own* knowledge, thus reproducing in the mental realm some of the supportive attributes of the interpersonal domain. On one hand, they are able to use personal knowledge to interpret or deal with immediate external situations. On the other, they are able to use these external examples to modify their personal knowledge. “This is a two-way, or dialectical, process and may go through a number of cycles” (Scardamalia and Bereiter 1991: 175).

This inner, two-way process has been exemplified by Scardamalia and Bereiter (1991), who asked pupils to speak aloud while engaged in a reading and writing task, in order to provide protocols of their thinking. Those pupils who were most successful in their studies noted new information which they could add to their memory store but expressed surprise at some factual items which seemed to contradict their prior knowledge. As a result, they added new facts to their pre-formed concept, but they also modified their ideas in order to accommodate discrepant information. Scardamalia and Bereiter believe that the extra effort these writers put into the dialectical process “builds easier access routes in discovering previously unrecognised connections among items of knowledge, and that the greater connected-ness facilitates the comprehension and retention of new information” (Scardamalia and Bereiter 1991: 179). They relate this observation to the experience of professional writers, who “often testify to the value of writing in

developing their own knowledge and understanding: a process of discovery, creating order out of chaos” (Scardamalia and Bereiter 1991: 179): an experience which has indeed been noted by the present author.

Some of the evidence for this dialectical process was observed by Scardamalia and Bereiter in some more expert pupils in a science lesson. After using their domain knowledge of physics in a problem-solving task, the pupils were observed to pause after solving a problem, “seemingly to extract generalisable knowledge from the experience” (Scardamalia and Bereiter 1991: 176). Of course, engagement in this two-way process “may go some way toward explaining how experts got to be expert in the first place” note Scardamalia and Bereiter (1991: 78).

2.6.4 A socio-cultural perspective on science lessons

Since science is seen as comprising processes as well as concepts, it is possible to apply the notion of socio-cultural learning both to the practical and theoretical aspects of the subject. In particular, teaching for understanding involves bringing what is already known into conscious mind in order for connections to be made with the new material: “What is needed is for the teacher to select learning activities that engage the learners’ prior knowledge ... [and are] designed to encourage children to see how the new learning relates to or changes their prior beliefs” (Stevenson and Palmer 1994: 181).

A five-step constructivist approach for teaching science which incorporates both practical and theoretical learning is described by Driver (1983). Firstly, in order for pupils to bring into conscious mind the ideas they already hold, teachers give pupils a practical activity which will help orient them toward the topic. Then pupils carry out elicitation tasks in which they make their ideas explicit. When they demonstrate correct but incomplete understanding, they are given follow-up activities to develop their ideas further. However, when misconceptions are revealed pupils are given discrepant experiences designed to challenge their thinking. Finally, they are encouraged to discuss their ideas.

Unfortunately, the outcome of the constructivist approach has been disappointing. “Research has come up with a surprise: ... where prior beliefs and instruction are incompatible, it is rare for resolution of contradictions to occur” note White and Gunstone (1992: 79). Very often one proposition does not win out over the other: “Rather, both views are stored in memory. .. the teacher’s statements are recalled in the context of the classroom and school-type tests and the experience-based self-

constructed knowledge in the context of everyday life” (White and Gunstone 1992: 79).

Although the five-step constructivist approach to teaching involves the teacher in helping children develop their ideas it does not describe a scaffolding process to aid the construction of personal understanding. As Bliss, Askew and Macrae (1996: 45) contend, “as yet, research focusing on the nature of scaffolds and their functions in specific schooling contexts is limited”. They argue that even when science teachers have been involved in training on how to perform scaffolding they have not been able to carry it out in practice. In classroom observations Bliss and her colleagues discovered that secondary “teachers could ‘talk scaffolding’ but appeared to implement it only marginally. Their focus was on teaching rather than on pupils’ learning” (Bliss et al. 1996: 45). It appears that Bliss and her colleagues have identified an important area for development, since “it would seem that experts do have to help novices package the environment - indeed there is a premium on their being able to do so” (Gelman 1991: 319).

In primary school classrooms, too, there is little evidence of support for the development of understanding, according to Newton and Newton (2000). While acknowledging that “children must make connections for themselves,” they believe that the process can be supported “by discourse to do with causal connections and relationships” (Newton and Newton 2000: 600). Instead they found that teachers’ discourse was “largely confined to developing vocabulary and descriptive understandings of phenomena and situations” (Newton and Newton 2000: 603).

Despite these disappointing discoveries, a process for scaffolding the integration of personal knowledge through reflection has been devised by Davis and Linn (2000). They designed a series of prompts to encourage lower secondary (USA eighth grade) pupils to add and reorganise information, to promote some ideas and demote others. Their efforts produced diverse responses from students. Those who focused upon their ideas as the researchers planned made significant gains. However, those who focused upon activities or who indicated that they understood everything did not. “The successful students were better able to note areas in which their own understanding was lacking and to engage in knowledge integration” conclude Davis and Linn (2000: 836).

Even when children generate empirical evidence in support of scientific ideas, they need help in its interpretation. For example, Foulds, Gott and Feasey (1992) found that from the age of seven to eleven years “the status of evidence particularly in

terms of validity is difficult for many children” (Foulds, Gott and Feasey 1992: 3.26). Even above the age of eleven “a majority produced conclusions which were not in keeping with the data at all” (Foulds, Gott and Feasey 1992: 4.29).

2.7 Conclusion

On one hand, much general support for the constructivist view of learning has been presented in this chapter. On the other, it has been argued that the five-step approach to constructivist teaching has had only limited success, causing dissatisfaction with the whole idea of constructivism among some science educators.

Despite these criticisms, the formulation of socio-cultural approaches to promote the construction of science knowledge in school appear to be still in their infancy. The present author suggests, in explanation, that much work on the process by which knowledge is constructed is confined to specialist psychological literature which has not been communicated effectively to educationists. In particular, because many science educators are concerned with older pupils, the information available in the developmental literature has not been exploited. This literature is the subject of the next chapter. At a time when there is a danger that pedagogy may fall back into didactic mode, it is the purpose of this thesis to explore further some early stages in the process by which knowledge and understanding develops.

CHAPTER 3

THE FORMATION OF IDEAS ABOUT BIOLOGY IN YOUNG CHILDREN: A REVIEW OF THE DEVELOPMENTAL LITERATURE

3.1 Introduction

Developmental psychologists are concerned with the mental transformations which occur during cognitive development. While accepting knowledge to be the result of personal construction, they are concerned to identify developmental processes which are experienced by all children. In particular, the importance of organising factual knowledge into concepts and theories, a concern of educators identified in the previous chapter, is recognised here. Utilising examples taken from biological topics, the aim of this chapter is to provide an overview of developmental research relating to this issue.

3.2 Outline

The chapter begins with a discussion of Piaget's stage theory of cognitive development, using the example of his work on children's notions of what it means to be alive. This theory provides the foundation for much of the developmental work that follows. Recent research relating to the development of children's ideas about life, the cause of infectious disease, the life cycle of flowering plants and inheritance elucidates both the nature of children's developing understanding and the way factual knowledge is organised.

There is another field of study where recent empirical work has produced information relevant to the questions posed by developmentalists. This is cognitive neuroscience. Some findings from this branch of psychology are employed in an attempt to produce a coherent account of the development of children's ideas.

The final section of the chapter explores the particular challenges in working with young children.

3.3 The work of Jean Piaget

Jean Piaget was the first researcher to recognise that qualitative changes take place in children's thinking from birth to adulthood. Thus, "it is thanks to Piaget's genius

that children are no longer viewed as little and imperfect adults” (Demetriou, Shayer and Efklides (1992: 1-2).

3.3.1 Piaget's stage theory

Although the psycho-social aspect of children's intellectual development is recognised by Piaget, his own research was directed to “what the child learns himself, what none can teach him and he must discover alone” (Piaget, 1973: 2). His theory of cognitive development provides an explanation for how information gained through the senses can be organised into a coherent framework of conceptual understanding. According to this theory, Piaget does not view learning as the gradual accretion of factual knowledge. Rather, he sees development as a series of transformations in mental structures, with children's thinking going through some relatively abrupt changes over comparatively brief periods of time. Furthermore, he argues that the mechanisms which bring about these changes are operative across subject boundaries.

As the instigator of the ideas of constructivism described in the previous chapter, Piaget believes that “nothing is innate ... everything must be gradually and laboriously constructed” (Piaget, 1973: 15). From his own observations he concludes that infants deliberately develop their knowledge through a process of trial and error as a result of physical actions upon the material world. They organise this knowledge into schemes which are rehearsed and consolidated through play. This construction of knowledge about the world through sensory experience and physical action is called by Piaget the *sensori-motor phase* of development, characterising the first two years of life.

According to Piaget (1969), a new stage emerges as children begin to use language. By thinking in words, individuals are no longer imprisoned in the present but can also deal with the past and future and create powerful images. However, language is just one of the symbols children use to represent the world. For example, at around the age of two years children can recognise that pictures stand for real objects. They can also engage in pretend play, using objects to stand for absent items, and enact imagined situations. This *pre-operational stage* is thought to last approximately from the age of two to seven years. It is during this stage that children ascribe human characteristics to inanimate objects, as Carey (1985) found. Details of this are described below.

Once children are able to manipulate their thoughts (a process termed *mental operations* by Piaget), and to organise them into more encompassing systems, they are said to have reached the *concrete-operational stage*. According to Piaget (1969), children are much more able to solve problems and to carry out logical thinking at this stage, providing that the tasks are related to real objects and events. Since they are able to integrate the factual knowledge they have gained through their senses at this stage, children can begin to make meaningful links among related ideas.

Only when individuals are able to engage in abstract thought, some time after the age of eleven years, does Piaget (1969) regard them as having reached the *formal-operational stage* achieved by adults. Indeed, some individuals may never reach this stage. It is only through the reflective abstraction of formal operations that it is possible to think about knowledge already possessed without reference to the external world.

Piaget's study of children's conception of life

Scientists ascribe seven characteristics to living things. These are: movement, sensitivity, feeding, respiration, growth, excretion and reproduction.

In his classic book, Piaget (1929) identifies the ideas children express at different stages in relation to what it means for something to be alive. Using the clinical interview, a research technique he adapted from clinical practices, his purpose was to probe the theories underlying children's explanations.

Working in the third decade of the Twentieth Century, Piaget was neither constrained to state the number of subjects in his sample nor their social composition. He asked children living in his home town of Geneva whether each of a number of objects (for example, a bicycle, a tree, and a gun) is alive, and why. Then he asked supplementary questions such as, "Which is more alive, a stone or a lizard?" As he was looking for stages of progression in children's thought, he categorised the responses accordingly.

Piaget identified four stages in children's ideas. At the very first stage that it is possible for children to engage in such questioning (from about four years of age), they appear to believe that anything which shows activity is alive. For example, a child stated that "The sun is alive because it gives us light" (Piaget 1929: 196). At this stage the attribute of life is associated with an object's ability to fulfil its role. Also, the cause of a physical action is not differentiated in a child's mind from

psychological intent. The youngest children simply talk about things in the terms used for human beings, “thus endowing them with will, desire, and conscious activity” (Piaget 1929: 210).

At the second stage, subjects link life to movement. For example, a child said, “A bicycle is alive because it sometimes moves” (Piaget 1929: 199). Piaget suggests that children at this stage cannot differentiate between mechanical movement (which requires an external force) and biological movement.

At the third stage, life is associated with spontaneous movement. For example, one child said that a horse is alive “because he helps man”, but then stated that a bicycle is not alive, “because it’s we who make it go” (Piaget 1929: 202).

Finally, at the fourth stage, children reach the untrained adult level of restricting the attribute of life to animals, or to animals and plants.

The ages of the children whose responses are provided by Piaget do not coincide with the normal age range he identifies with each stage. Thus the examples given of responses illustrating the first stage are from children aged from eight years to eleven years and seven months, even though Piaget states that this stage normally lasts only up to the age of six or seven. In this way it can be seen that Piaget did not derive his theory from the data presented here, but instead used the data to illustrate his domain-general stage theory.

3.3.2 Criticisms of Piaget’s stage theory

Piaget’s work has been highly influential for the following reasons:

Fundamentally what Piaget’s work showed was that children’s ideas about the world are importantly different from those of the adult, and certainly from those of the science teacher, and if that ‘knowledge’ is so evidently an evolutionary process, then all the stages leading up to it must be vital to the child. Thus the way in which children understand the world at any given moment, though to adults may appear wrong, or strange, or even childish, is of great importance to them. Each new step in understanding is like a springboard to the next stage.

(Bliss 1993: 40).

Indeed, “as a theory [Piaget’s] view has much to commend it. It has a high level of internal consistency, wide field of application, and in some respects, is capable of empirical exploration” note Brown and Desforges (1979: 20).

However, although Piaget's insight broke new ground and raised "a huge number of interesting questions" (Brown and Desforges, 1979: 49), it also generated much controversy. The domain generality, cultural independence and transformation of these stages have all been questioned as well as the very nature of his research techniques.

Domain generality

Domain generality is a fundamental attribute of Piaget's stage theory. However, Brown and Desforges (1979: 90) claim that "the data quite clearly show that the degree of coherence of performance the theory has led researchers to expect is not manifest in the results", a finding which leads Demetriou and colleagues (1992: 2) to explain that "an individual child can be shown to be at one operational level in one domain, while being at another level in a different domain".

Cultural independence

The universal nature of Piaget's conceptual stages is questioned by Bidell and Fischer, who explain that the two major ways in which the role of experience has been explored are cross-cultural studies and training studies. They note that "far from being universal, it is found that the activities from which knowledge is constructed must take place in specific contexts in relation to particular tasks" (Bidell and Fischer 1992a: 110). In fact, Case (1992: 171), believes that "the content of Piaget's higher levels is the product of Western thought, and therefore cultural in nature". Certainly, "it is frequently found that formal operational thinking is absent in primitive societies" (Brown and Desforges, 1979: 66), a discovery which can be explained by the "very large number of studies ... [which] show that experience does influence cognitive growth" (Brown and Desforges, 1979: 79). In any event, "using cross-cultural research to explore the role of experience leaves us with something of a dilemma. Standardised tasks are seen as artificial and lacking in significance whilst natural behaviour sequences are ambiguous and open to a variety of interpretations" (Brown and Desforges, 1979: 63).

Transformation of the cognitive stages

One of the notions implicit in Piaget's view of development as analogous to biological epigenesis, according to Brown and Desforges (1979: 23), is that it involves a "stepwise growth through a series of stages". The question these authors raise is how to test stage theory. They reason that a stage does not come about by some instantaneous transformation, so the experimenter should be prepared to find

cognitive disturbances in transitional subjects. If this is the case, it is possible that in each cohort there would be some who had already achieved full mastery of a stage, and others who were in various transition stages. Yet Brown and Desforges argue that in many studies this pattern is not manifest. They conclude that “Piaget’s descriptions represent accounts of underlying competence ... thus it is not a psychological theory at all” (Brown and Desforges, 1979: 93 - 4).

Another criticism of Piaget’s stage model is that whereas he sees each stage subsumed in a higher one, Donaldson (1992: 126) argues that “because the use of the intellectual transcendent mode is very demanding the normal individual frequently seeks refuge in lower levels of thought”.

Piaget’s research techniques

Piaget’s research techniques have been criticised on the grounds that the way questions are posed to young children can seriously affect the outcome of an investigation into their thinking. For example, Donaldson (1978) discovered that when she questioned children in a context that was familiar she evinced a much higher level of performance than did Piaget. In confirmation of this finding, Siegal argues that when given more suitable wording for questions it can be demonstrated that “young children actually know a good deal about abstract concepts, for example, of causality, and the identity of persons and objects” (Siegal 1991: 1).

Brown and Desforges (1979) suggest that in interpreting a child’s performance on a task there is the risk of making one of two types of error, a false positive error or a false negative error. In the case of false negative errors, “the child could be inattentive, might not comprehend the instructions or might not remember the instructions. These would be errors originating in the stimulus demands of the task” (Brown and Desforges, 1979: 120). Another source of error lies in the response demands of the task. “The child might be perfectly able to cope with the task intellectually but the response we demand might be beyond his capabilities” (Brown and Desforges, 1979: 121). They believe that “the evidence of Piaget’s propensity for false negative errors is extensive” (Brown and Desforges, 1979: 121).

Another source of false negative errors is that Piagetians demand from their subjects explanations for their judgements. Brown and Desforges (1979: 128) argue that such a demand “builds in to their data false negative errors from the point of view of their own theory”. According to these authors, “the use of hints could reduce the incidence of false negative errors by eliciting manifestations of competence otherwise obscured by ambiguous instructions” (Brown and Desforges, 1979: 129).

However, they caution that “the effects of hints are radically different at different ages” (Brown and Desforges, 1979: 131). They also note that “Piaget himself ... observes that language expresses thought only in a very rough way and that there are large differences in verbal expression between individuals which are independent of cognitive structure” (Brown and Desforges, 1979: 135).

The use of training studies could be used to explore the transition from one stage to the next, where “operative understanding [is employed] to establish that development has actually taken place” explain Brown and Desforges (1979: 145). However, “Genevans continue [instead] to insist on judgements plus explanations” (Brown and Desforges 1979: 145). Furthermore, they suggest that “with respect to durability and generalisation of acquired operations, the only sensible source of criteria would come from detailed longitudinal studies which explored the durability and generalisation of operations as they occurred naturally” (Brown and Desforges, 1979: 146) but these workers regret that “at present we do not have such studies” (Brown and Desforges 1979: 146).

Brown and Desforges’ overall criticism is that “a great deal of the research generated by Piaget’s theory ... is less ‘theory driven’ than ‘phenomenon driven’” (Brown and Desforges, 1979: 137) and that the theory is “in many respects untestable” (Brown and Desforges, 1979: 162). They conclude that “the notion of stage creates more conceptual problems than it solves. Furthermore, contemporary process research proceeds perfectly well without the concept of stage and emergent functions” (Brown and Desforges, 1979: 166).

Despite these criticisms, Case (1992a: 166-7) believes that three of Piaget’s ideas relating to stage theory should be retained. Firstly, he believes it is possible to identify three or four general levels of cognitive structure in development, leading from the sensori-motor to the increasingly symbolic and abstract. Secondly, in contradiction of Donaldson’s view, he argues that each stage builds on and transforms earlier ones. Thirdly, he identifies characteristic ages for the acquisition of structures at any major levels, given an optimal environment. However, he suggests that “children’s ideas are better defined in terms of their form, complexity, and levels of hierarchical integration, rather than in Piaget’s terms of symbolic logic” (Case 1992a: 170).

Brown and Desforges (1997: 49) acknowledge that “In almost all cases, Piaget’s critics accept his observations. They assert, however, that there are alternative explanations ... [which] have never been eliminated by Piagetians [and] that the

alternatives are more testable ... and fit the data better than the Genevan theory". Therefore, they suggest that "it makes more sense to try to identify cognitive processes from the study of empirical evidence rather than to search for the presence or absence of constructs (like transitive inference) which have been derived from a logic-model of intellectual development and which have never been specified in psychological terms" (Brown and Desforges, 1979: 59). Moreover, Trabasso (1977: 365) argues that "for the most part, we have found that children can, in fact, reason like adults. Adults, in turn, seem to employ reasoning strategies like children".

3.3.3 The individual construction of knowledge

There is another strand in Piaget's thinking which is somewhat at variance with his stage theory. In fact, Bidell and Fischer (1992b: 11) maintain that "there has always been a tension in Piagetian theory between its constructivist framework, where knowledge is the product of the individual's activity on the one hand, and its structuralist stage model based upon universal structures on the other".

The Piagetian perspective is that "learning is always an interpretive process and always involves individuals' constructions" note Tobin, Kahle, and Fraser (1990: 6-7). When learners come across empirical data that are at odds with the explanations they have created, there is cognitive conflict, and the equilibrium of their ideas is disturbed. Then they must reorganise (or restructure) their ideas in order to make sense of (accommodate) the new information. In this way, children are seen as little scientists, systematically investigating the material world.

According to Keil (1991: 239), "Science, after all, differs from common sense only in degree of methodological sophistication". Be that as it may, Claxton argues that young children cannot create knowledge in the way that scientists do. They are "scientists of a sort ... they are inquisitive, but they are impulsive and inexperienced scientists. Their experiments are public and risky, often clumsily performed and resulting in distress or panic" (Claxton 1991: 90).

There is a further justification for caution in describing children as little scientists. This is their restricted ability to engage in causal reasoning. Certainly, it has been demonstrated that young children do indeed "reason in accordance with causal principles, and do so surprisingly early in development" (Goswami 1998: 157). Nevertheless, their powers of reason are limited, so that "in situations where there are multiple potential causes, they tend to make inclusion errors, attributing causal

status to variables that may only co-vary with a particular outcome on a single occasion" (Goswami 1998: 157).

In sum, it can be seen that although there is general acceptance that young children do construct their own knowledge, they do not always take account of available evidence in the manner expected of scientists.

3.3.4 The questions of innateness and the modularity of the mind

Some contemporary workers believe, with Piaget, that infants are born with no innate predisposition for particular knowledge; for example, Fischer (1991: 231), who states that "there is no compelling evidence in support of the view that knowledge is specified innately". Others, such as Carey, identify primitive theories which they regard as pre-specified in new-born infants:

My guess is that the "initial state" of human children can be described by saying that they are innately endowed with two theoretical systems: a naïve physics and a naïve psychology ... we cannot ignore the problem of the specification of the initial state when we seek explanations for developmental changes.

(Carey 1985: 200)

The idea of innate theoretical systems emerges from Carey's own empirical work, some of which is reviewed later in this chapter.

While remaining silent on the issue of innateness, Diamond makes a case for the early possession of knowledge: "I propose that infants know a good deal more about objects than Piaget gave them credit for knowing" (Diamond 1991: 67). To be sure, early knowledge need not necessarily be innate. Rovee-Collier's (1990) empirical work demonstrates that even very young babies are capable of learning, for example that they can control the movement of a mobile by kicking a leg to which a pull-string has been attached.

However, Spelke (1991) questions both the sensorimotor origin and the reconstruction of children's knowledge:

Capacities to perceive, represent, and reason about the world do not appear to depend on the emergence of the sensorimotor co-ordinations that Piaget described, ... the development of representation and reasoning appears to resemble a process of enrichment rather than a process of conceptual revolution.

(Spelke 1991: 165)

Another perspective on the question of the initial state of neonates is that of mental modules. According to Karmiloff-Smith (1992: 1-2), “Fodor’s 1983 book *The Modularity of Mind* made a significant impact on developmental theorising by suggesting how the nativist thesis and the domain specificity of cognition are relevant to constraints on the architecture of the human mind”.

In his book, Fodor (1983: 1) introduces the idea of mental modules by explaining that “many fundamentally different kinds of psychological mechanisms must be postulated in order to explain the facts of mental life”. For example, there appear to be “differences between sensation and perception, volition and cognition, learning and remembering, or language and thought” (Fodor, 1983: 1). For Fodor (1983: 2), “a proposed inventory of psychological faculties is tantamount to a theory of the structure of the mind ... [so that] the structure of behaviour stands to mental structure as an effect stands to its cause”.

These ideas, which Fodor describes as Neocartesian, can be contrasted with Piaget’s idea of domain-general development, because Fodor (1983: 3) holds that “the mind is (initially, intrinsically, genetically) structured into psychological faculties”. He believes it “entirely plausible ... that for mental faculties, as for bodily organs, ontogenetic development is to be viewed as the unfolding of an intrinsically determined process” (Fodor, 1983: 4), that is, development of the mind takes place in a similar way to the growth of body parts (such as arms and legs).

Fodor (1983: 41) proposes “a trichotomous functional taxonomy of psychological processes ... which distinguishes transducers, input systems and central processors”. The input systems “function to get information into the central processors by mediating between transducer outputs and central cognitive mechanisms” (Fodor, 1983: 42). They encode mental representations from the senses. Transducer outputs, on the other hand, specify “the distribution of stimulations at the ‘surfaces’ (as it were) of the organism” (Fodor, 1983: 42). It is the input systems that Fodor considers modular: “what the input systems have in common is that they are modules” (Fodor, 1983: 46). He describes them as “domain specific” (Fodor, 1983: 47), “mandatory” (Fodor, 1983: 52), and having “only limited central access to the mental representations that output systems compute” (Fodor, 1983: 55). They are “fast” (Fodor, 1983: 61), “informationally encapsulated” (Fodor, 1983: 61) and “have ‘shallow’ outputs” (Fodor, 1983: 86), associated with “fixed neural architecture” (Fodor, 1983: 98). Thus, according to Fodor, information from the external environment first passes through a system of sensory transducers, which

transform the data in a common format suitable for central, domain general processing.

In response to Fodor's work, Karmiloff-Smith (1992: 4), argues that "development involves a process of going beyond modularity". While endorsing the importance of Fodor's thesis for understanding the architecture of the human mind, she provides "a view that differs from the notion that modules are prespecified in detail", questions "the strictness of the dichotomy that Fodor draws between modules and central processing" and challenges "Fodor's contention that the outputs of input systems are automatically encoded into a single common language of thought" (Karmiloff-Smith 1992: 4).

In contrast to Fodor's account, Karmiloff-Smith 1992: 4) wishes to "draw a distinction between the notion of prespecified modules and that of a process of *modularisation*" which she speculates as occurring repeatedly as the *product* of development. She believes "it is plausible that a fairly limited amount of innately specified, domain-specific predispositions (which are not strictly modular) would be sufficient to constrain the classes of inputs that the infant mind computes" (Karmiloff-Smith 1992: 4). She suggests that "*with time*, brain circuits are progressively selected for different domain-specific computations [so that] relatively encapsulated modules would be formed" (Karmiloff-Smith 1992: 5). Thus Karmiloff-Smith (1992: 5) believes that "Nature specifies initial biases or predispositions that channel attention to relevant environmental inputs, which in turn affect subsequent brain development".

Returning to Piaget's idea of epigenesis, Karmiloff-Smith argues that "the modularisation thesis allows us to speculate that ... domain-specific predispositions channel the infant's early development, [an] endowment [which] interacts richly with, and is in turn affected by, the environmental input" (Karmiloff-Smith 1992: 5).

Karmiloff-Smith draws a distinction between the terms "module" (an information-processing unit that encapsulates knowledge and the computations on it) and "domain" (the set of representations sustaining a specific area of knowledge). Invoking the notion of Representational Redescription (described in chapter two), she argues for "a *phase* model of development, rather than [Piaget's] *stage* model" (Karmiloff-Smith 1992: 46).

In agreement with Fodor, Karmiloff-Smith believes that the nativist/modularity thesis projects a very different picture of the young infant from that envisaged by

Piaget because “the neonate is seen as preprogrammed to make sense of specific information sources” (Karmiloff-Smith 1992: 8). Thus, contrary to the Piagetian infant, “the nativist infant is off to a very good start” (Karmiloff-Smith 1992: 8). However, she argues that “Fodor’s concentration on input systems ...doesn’t help us to understand the way in which children turn out to be active participants in the construction of their own knowledge” (Karmiloff-Smith 1992: 10). Her idea of a “progressive process of *modularisation* as opposed to [Fodor’s] prespecified modules” (Karmiloff-Smith 1992: 10) allows for Piaget’s epistemology to be salvaged. By accepting that infants and young children are active constructors of their own cognition she involves “both domain-specific constraints and domain-general processes” (Karmiloff-Smith 1992: 11). Thus she believes that “in sum, there seems to be something right about both Fodor’s and Piaget’s approaches to human cognition” (Karmiloff-Smith 1992: 11).

3.4 Post-Piagetian research on the development of children’s biological ideas

In the topics which are examined below, a detailed review is limited to those studies which investigate conceptual development in young children in the context of biology.

Siegal and Peterson (1999) identify two post-Piagetian orientations in the field of contemporary research on the development of biological concepts. These are firstly, the idea of naïve theory and conceptual change, as exemplified below in accounts of the development of a theory of life, and secondly, an adaptive-evolutionary orientation related to the basic need for food, shelter and reproduction. The latter is exemplified below in studies relating to plant life cycle and animal inheritance.

3.4.1 The construction of a theory: post-Piagetian research on the meaning of ‘alive’

Table 3.1 provides a summary of the four studies reviewed relating to children’s developing theory of the properties of life.

Although Carey does not endorse Piaget’s stage theory, she certainly embraces his ideas of assimilation, accommodation and conceptual change in the interpretation of her own empirical findings. Above all, Carey emphasises that the restructuring of concepts is a feature of children’s developing ideas, either by the splitting apart of previous wholes or by the combination of separate entities: “Changes of this sort go beyond mere enrichment. New ontological distinctions come into being, and in

terms of this distinction, entities previously distinct are seen to be fundamentally the same” (Carey 1991: 290).

Table 3.1 Post-Piagetian research on the properties of life

Name	Year	Country	Mean age	Sample size	Topic
Backscheid-er et al.	1993.	Michigan, USA			Re-growth as a life characteristic
1			4	24	Categorisation of living/non-living
2			3/4	19/16	As above
3			4	18	Generalisation to unfamiliar objects
Carey	1985	Massachusetts, USA			Theory of biology
1			4/7/10	10/10/10	Piaget’s stages
2			4/7/10	10/10/10	Attribution: properties of life
3			4/5/7/adult	9/9/9/9	Attribution: animal properties
2a			4/7/10	10/10/10	Deductive inference
4			4	20	Humans the most accessible animal?
5			4/adult	20	Mechanical monkey like a person?
6			4/6/10/adult	51/51/51/51	Use of human as exemplar
7			6/adult	25/20	Inductive projection
8			6/adult	59/60	Role of ‘animal’ & ‘living thing’ in reasoning
Gelman, R.	1990	Pennsylvania, USA			Animate/inanimate distinction
1			3/4	20	Causes of motion in animate/inanimate objects
2			3/4/5	30	Insides of animate/inanimate objects
Slaughter et al.	1999	Massachusetts, USA			Life and death
1			4.1 - 5.11	38	Bodily organs and processes
2			4.1 - 5.11	38	Death

Having rejected Piaget’s domain-general stages of development, Carey (1985) looked for an alternative explanation for Piaget’s findings. Together with various colleagues, she searched for evidence which would confirm Piaget’s contention that young children’s view of the natural world passes through fundamental changes

before reaching that of older children and adults. She probed in particular his suggestion that the underlying theories of young children must be reorganised or restructured before more adult concepts can be held and also for a mechanism for the changes entailed.

Carey began by confirming Piaget's original finding: young children do indeed state that inanimate objects such as bicycles and the sun are alive. However, there are two possible explanations for this phenomenon other than that of Piaget's conceptual stages. It has been suggested that this result might be simply the product of semantics: young children do not understand the meaning of the word, *alive* to mean *living thing* in the way adults do. Carey notes that in some cases children were making a distinction between *alive* and *dead*, as in, 'dead animals'. In other cases they were making a distinction between *alive* and *extinct*, as on the occasions dinosaurs were mentioned. In addition, a child might think the experimenter intends the distinction between real or imaginary, or between real and a representation. Another explanation for Piaget's findings might be that his procedure of the clinical interview traps children into making animistic judgements about inanimate objects simply by asking for a justification of each statement. For example, "having just said that a bird is alive 'because it flies,' a child might feel compelled for the sake of consistency to judge an airplane alive" (Carey 1985: 35). In the light of these criticisms of Piaget's work, Carey devised a different procedure to determine whether children aged from four to six years would ascribe properties of living things to inanimate objects. They did. When asked whether each of a set of objects had attributes such as growing, eating and breathing, children frequently ascribed these living properties to inanimate objects as well as to animate ones. Furthermore, responses for familiar items were similar to those for the unfamiliar ones. Carey (1985: 25) concludes that "the phenomenon of judging inanimate objects alive [by younger children] ... is remarkably stable". However, only those who tried to encompass animals and plants in a single category judged inanimate objects to be alive. Those young children who restricted attribution of 'alive' to animals alone did not make animistic errors.

Supposing that young subjects simply lack factual information about plants and animals, Carey tested a series of hypotheses to investigate their understanding of the properties of animals rather than living things in general. She acknowledges that "the word 'animal' poses a similar semantic problem to the word 'alive'. A child might have the adult concept of *animal*, but does not use the word, 'animal' to express it" (Carey 1985: 73). In fact, she points out, speakers of English use the word 'animal' in three different but important ways, thus making a child's

understanding and use of the word problematic. Whereas the biological concept of *animal* contrasts animals with plants and with inanimate objects, as in 'the animal kingdom', another use contrasts animals with people, as in 'Don't eat like an animal'. Finally, the word 'animal' can be used to mean roughly 'mammal', as in 'birds, bugs, snakes, and animals'.

Carey's experiments were designed to overcome this problem. She questioned children about animal *properties* rather than using the word 'animal'. For example, in her first experiment she asked children whether each of a series of objects eats, breathes, sleeps, can get hurt and has a heart (properties of animals). From her results Carey concludes that four- to seven-year-olds have a clear concept of animals, as distinct from inanimate objects, but as yet they do not have a concept of living things as distinct from inanimate objects. In contrast, by the age of ten years many children have achieved the biological concept *living thing* and have mapped it onto the word 'alive'.

Carey argues that young children do not have a sufficient knowledge base for the inclusion of animals and plants in a single category of things that are alive, as older subjects do. As a result, the concepts *animal* and *living thing* play quite different roles in the inductive reasoning of six-year-olds compared to adults. It appears that young children decide whether each object (animate or inanimate) has certain internal organs (e.g. a heart and bones) and bodily functions (e.g. eating and breathing) by comparing it to people, whereas older children and adults use definitions and category membership in their decisions. So at first, "The young child distinguishes between animals and inanimate objects, but has not yet coalesced the concepts animal and plant into a single ontological type, *living thing*" (Carey 1985: 170). As a result of further work, Carey (1985) concludes that young children also fail to use a *living kinds* category in inductive reasoning and argues that children use naïve psychology, rather than naïve biology, when making inferences about animals. An adult response, indicating understanding of animals and living kinds was not found until the age of ten years.

It follows, according to Carey, that biological knowledge is restructured during the years from age four to ten. Since the judgements of young children differ so markedly and systematically from those of adults, she suggests that this is the result of change in a child's theories in order to arrive at explanations. "It is explanatory mechanisms that distinguish theories from other types of conceptual structures. Explanation is at the core of theories" (Carey 1985: 201). She explains that the two successive conceptual systems will be structurally different in the *weaker* sense if

the later one represents different relations among concepts than the earlier ones. However, they are different in the *stronger* sense if the transition between the two involves conceptual change. She believes that between the ages of four and ten years, knowledge of animals is restructured in at least the weaker sense. The first distinction is between knowledge accumulation that involves restructuring (e.g. theory change and novice-expert shifts) and knowledge accumulation that does not. The second distinction is between domain-general change and domain-specific change. Carey suggests that both conceptual differentiation and coalescence can occur. Also, she believes that sometimes simple properties can be re-analysed as relations. Thus although Carey (1985) argues for structural change in children's conceptual systems, she does not support Piaget's claim that it is domain-general.

Carey's work was the stimulus for further studies about children's understanding of 'alive' as described below.

Children's reasoning about re-growth as an attribute of living things

To form a living kinds category, children must group plants and animals together based on largely non-obvious properties (for example, inheritance) argue Backscheider, Shatz and Gelman (1993: 1244), who explain that "this may be difficult for pre-schoolers who have little biological knowledge, especially of plants". Re-growth was therefore chosen as their criterion in testing children's reasoning about the attribute of life, as this is something about which children do know something in both plants and animals.

It was found that four-year-olds knew that living things can heal through re-growth and that people can mend artifacts. Moreover, four-year-olds knew that artifacts do not heal through re-growth and that on the whole people cannot fix living things. Thus by treating plants and animals similarly, children demonstrated at least the prerequisites for a living kinds category, which Carey judged to be absent at this age. They knew something of the living kind-artifact distinction and about different types of transformations. Children were also able to provide appropriate reasons for their statements. For example, they tended to mention specific methods of human intervention for the way a person can mend something. However, three-year-old children were less knowledgeable than four-year-olds.

The use of domain-specific principles

Do three- and four-year-old children show evidence of Piaget's domain-general stages, or do they use domain-specific principles? Gelman (1990) carried out two judgement tasks to find an answer to this question. When asked which of a

children could give an appropriate, specific function for each body part but that only twenty mentioned maintaining life on at least two occasions overall. On the basis of the second finding it was possible to divide the children into two groups of similar age; those who were presumed to have a theory of life and those who did not. The transition between non-life-theorising and life-theorising was thus seen to occur between the ages of four and six years.

The second experiment conducted by Slaughter, Jakkola and Carey (1999) was designed to test the hypothesis that only the life-theorisers (who had undergone a conceptual change) would have a biological concept of death. All thirty-eight children were asked a number of questions about death, including what it means for something to die, naming some things that die, deciding whether a person who is dead has certain bodily needs such as food and air, knowing how to tell if a person is dead and deciding whether a doctor could make a dead person alive again.

It was found that all the children could give appropriate examples of things that die, although the life-theorisers more frequently included plants in their list. However, there was a significant difference between children in the two groups with regard to their list of items that do *not* die. Whereas the majority of life-theorisers mentioned only artifacts, non-life-theorisers included living things such as trees and people in their list, indicating a lack of differentiation between the concepts 'not alive' and 'inanimate' as well as a lack of recognition that death is inevitable for people. There was also a significant difference between the two groups with regard to the irreversibility of death, and the cessation of bodily functions when death occurs. Some children (primarily the non-life-theorisers) asserted that dead people need food, air and water.

Whereas both groups said that dead people cannot move around, an unexpected finding was that both groups were equally likely to say that a dead person's cuts would heal. Other unexpected similarities between the two groups were revealed in their answers to questions about the potential causes of death and how one can tell if a person is dead. However, an unexpected difference between the two groups was that life-theorisers were more likely to say that the body decomposes when people die.

Taking into account these and a number of earlier studies, including those reviewed in this chapter, Slaughter, Jakkola and Carey believe that as a theory of biology is formed (based upon processes which maintain life), "it provides a structural basis for widespread change in children's biological concepts" (Slaughter, Jakkola and

Carey 1999: 92). So, “this cluster of concepts - life-death-body function - form a coherent, interrelated network of beliefs that ... itself constitutes the basic structure of the first, vitalistic, intuitive biological theory” (Slaughter, Jakkola and Carey 1999: 92). These authors describe the theory change in biology from a psychological to a biological one in the following terms. At first, over a period of time, the pre-school child learns separate items about bodily function and the components of an adult understanding of death (for example, that you would die if you did not have a heart). Then, an accumulation of such facts produces disequilibrating forces on the child’s undifferentiated concepts of life and death. Once a certain threshold is reached, these forces support a restructuring of knowledge so that in future the attribution of life and death is restricted to those creatures that have hearts, that is, animals and people. As soon as this theory of life is formed, it can direct and facilitate future learning. This process is described as ‘bootstrap’ learning, “a form of motor learning that needs no corrective information” (Jordan and Wolpert (2000: 613). This process can be contrasted with learning by trial and error, where both positive and negative feedback from the environment play a part.

3.4.2 Further work on theory construction: post-Piagetian research on the flowering plant life cycle and inheritance

The scientists’ view is that when living organisms reproduce themselves they pass on specific characteristics to their offspring. In sexual reproduction, heritable components are passed on in equal parts from both parents. Seeds are the penultimate, dormant stage in the sexual reproduction of plants.

Table 3.3 provides a summary of the four studies reviewed in this section. Hickling and Gelman’s study is of children’s understanding of the role of seeds in the life cycle of plants. The other studies relate to inheritance in animals including humans.

Testing the belief that the fifth year of life is critical in children’s developing a biological understanding of several aspects of plant growth and life cycle, Hickling and Gelman (1995) carried out three experiments which compared children whose mean age was below four years five months with those whose mean age was above four years eight months.

Children were asked where a little boy, Johnny, could obtain seeds for his garden. They were then asked what produces seeds and what grows from them. Finally, they were asked to help tell a story about how things grow, in order to tap their understanding of the cyclical, causal nature of growth.

Table 3.2 Research on flowering plant life cycle and inheritance

Name	Date	Place	Mean age	Sample size	Topic
Hickling and Gelman, S.	1995	Michigan, USA			Seeds and life cycle
1			4.2/4.9/adult	12/12/34	Plant growth process
2			4.4/4.1/4/9	16/16/15	Ontological status of seeds
3			4.3/4.9	12/12	Stages of life cycle
Springer	1992	USA			Inheritance in animals
1		Rhode Island, USA	4/6	32/32	Induction of biological properties
2		Rhode Island & New York, USA	4/6	18/18	biological v. social relations
3		New York, USA	4/6	22/22	Inherited v. acquired characteristics
4		Texas, USA	4	40	Order effect
Solomon, Johnson et al.	1996	Massachusetts, USA			Inheritance in humans
1			5/6/7/adult	16/16/16/16	Adoptive v. biological parents
2			5/6/7/adult	16/16/16/16	Inherited v. acquired characteristics
3			5/6/7/adult	16/16/16/16	Adoptive v. Biological parents
4			5	16	Adoptive v. biological parents
Johnson & Solomon	1997	Massachusetts, USA			Inheritance in dogs and cats
1			4/5/6/7/adult	16/16/16/16/16	Property origins
2			4/5/6/7/adult	16/16/16/16/12	Kind origins
3			5	17	Mother bias

As anticipated, evidence was found of developmental change between the two age groups. Younger four-year-olds frequently accepted that germination is initiated by people or by the seed's own intention, whereas older four-year-olds generally judged natural mechanisms to be responsible for seed growth. By the age of four years six months but not earlier, children consistently associated seeds with plants and fruit but not with animals. Older children also knew that seeds can come only from a same-species plant and that plants and fruit originate from seeds but animals

do not. However, they did not always expect to find seeds inside fruit. Most importantly, the older children evinced an early understanding of the distinct stages of the growth cycle, “suggesting that they view growth as generational and continuous” (Hickling and Gelman 1995: 873).

Hickling and Gelman believe they had evidence of theory change in action because the younger children viewed plants “through the lens of a psychological causal-explanatory framework, as well as more appropriately through a biological one” (Hickling and Gelman 1995: 874).

In an attempt to evaluate Carey’s (1985) position that young children think about animal inheritance in terms of human behaviour, Springer (1992) tested whether they believe kinship implies a closer biological relationship than physical resemblance or friendship. He found that both four- and six-year-olds judged kinship to be more important in determining the extent of shared biological properties among animals, showing that they do not reason in social terms about biological relations and discrediting the notion that pre-schoolers consider only surface features.

However, Springer suggests that the reason for children’s statements may be related to their conceptions of inheritance as natural, material transfer from mother to foetus: “Families, in the child’s view, are biologically closer - that is, share more biological properties - owing to their special origins” (Springer 1992: 958). He concludes that overall, young children are not perceptually bound. The only age difference found in the data was that older children were more able to articulate the reason for their decisions than young subjects.

Granted that pre-school children understand the general notion of resemblance to parents, as illustrated in Springer’s study, Solomon, Johnson, Zaitchik and Carey (1996) explored whether four- to seven-year-olds understand biological inheritance. Biological and adoptive relationships in humans were contrasted in two fairy stories. One was about a shepherd boy adopted by a king and the other a young prince adopted by a shepherd. The results displayed a consistent pattern which undermines the claim that pre-school children have a biological understanding of inheritance, since only one five-year-old differentiated between the origins of physical traits and of beliefs. Then children were asked whether a boy could change in various ways as he was growing up. Even the five-year-olds indicated that there are some bodily phenomena over which there is no intentional control.

In contrast to the first two experiments, female characters featured in the stories that followed. Only at age seven did most children give explanations that reveal an understanding of birth as part of a causal chain mediating the fixing of immutable physical features.

Fearing that the context of a fairy tale had led children to accept magical transformations, the final adoption story was about a woman who dies immediately after the birth of a child. In response to questioning, most pre-schoolers did not demonstrate an understanding of biological inheritance.

In continuation of this work, Johnson and Solomon (1997) told children cross-species adoption stories. For example, children were asked to help Mr. and Mrs. Dog find their baby. They found that the majority of children at all ages failed to distinguish physical and mental properties of animals on the basis of different causal origins and that knowledge of birth in five-year-olds was not biologically differentiated. They conclude that “it takes a long time for children to construct an explanatory theory of biological origins that can carry the inferential load of all these tasks” (Johnson and Solomon 1997: 417), so that only by the age of seven have the majority of children begun to form a causal theory of inheritance. These authors believe that “there are periods during the construction of new domains when children, or adults, have learned individual facts but have not yet analysed them in terms of their causal, explanatory roles” (Johnson and Solomon 1997: 417), a conclusion which supports the work reported above on the meaning of *alive*.

3.4.3 Socio/cultural factors in cognitive development

Earlier in this chapter it is indicated that Piaget’s ideas regarding children’s developing conception of the world follow universal principles. However, since all the research discussed so far was conducted with children raised within Western culture it is possible that the apparently normal trajectory of cognitive development is in fact a product of the socio/cultural milieu. Hatano and his colleagues’ (1993) international investigation of children’s ideas about what is alive addresses this issue. Details of this study are shown in table 3.3.

In order to discover the effect of culture upon learning, workers in Japan, Israel and the United States carried out an international study of children’s developing ideas about what it means to be alive. Using similar questions to those employed by Carey (1985), in her study of children’s ideas about the properties of animals and plants,

they discovered both important similarities and important differences among children from the three countries.

Table 3.3 The influence of culture in understanding the properties of life

Name	Date	Place	Mean age	Sample size	Topic
Hatano et al.	1993	Japan, Israel & USA	6/8/10	118/116/129	Cultural differences in biology

Children in all three countries knew that people, other animals, plants and inanimate objects were different types of entities with different properties. By age eight years more than ninety per cent of children judged correctly on almost all questions regarding people, other animals and inanimate entities.

However, the most striking differences were those between Israeli and Japanese children’s judgements; particularly those relating to plants and inanimate entities. Israeli children were more likely to indicate that the qualities of plants are not shared by all living things. Japanese children, on the other hand, were more likely to suggest that inanimate objects have attributes that are unique to living things. The explanation put forward by these researchers is that whereas Japanese culture (based upon Shinto Buddhism) sees a life force in the whole of nature, Judaism emphasises the life principle of people and other animals.

The overall levels of knowledge also differed among the cultures. Children in the United States responded more accurately than age peers in Japan and Israel. The authors believe this finding to be the result of the widespread availability of wildlife and information programmes on television and of similar topics in magazines in the United States but not in the other two countries.

In an international study of young children’s knowledge of distant environments, Palmer and her colleagues (1999) found both similarities and differences among the inhabitants of Greece, Slovenia and England. Whereas all three of these countries raise their children within a Western culture, the physical environment is different in each. It comes as no surprise, therefore, to find that Slovenian children, living in a richly forested country, should have the best knowledge of creatures that live in temperate woodland. On the other hand, knowledge of animals that live in tropical rain forests, an item unlikely to have been available for first-hand exploration by any of the children, was similar in the three locations.

Another worker who provides some support for the idea of the influence of culture is Walker (1999). She worked with both children and adults to explore the effect of culture on the development of their understanding of the categories of natural kinds and artifacts. The participants were rural, urban and elite groups of Yoruba people in western Nigeria. The rural participants had little formal schooling and made a living by farming and hunting. The urban participants lived in working-class neighbourhoods of major cities where they experienced a modest education. This was better than the education available in the rural villages. In contrast, the elite participants lived in affluent surroundings with excellent educational opportunities. The elite adults were all college or university educated professionals. All participants were given tasks in which they had to judge the identity of a natural kind or artifact which had undergone a superficial transformation. For example, a natural kind task described a professor who took a small tomato. He dipped it into a special liquid so that it became smaller, harder and tasted hot. Subjects were asked whether it was still a tomato or had become a pepper. Walker found that the urban and elite groups showed fairly similar developmental patterns in their preservation of identity judgements. The rural group, on the other hand, exhibited a steeper developmental trajectory. Although the rural adults were poorly educated, they did as well as the elite adults and better than the urban adults. Walker's explanation is that rural children's early knowledge of natural kinds was more practical and immediate than that of the other two groups. She discovered that both biological and supernatural explanations offered for the changes increased with age. The rural adults gave over two-thirds of the supernatural explanations, a finding which Walker takes to be an indication of the influence of their socio/cultural background, which "blurs the line between the secular and the supernatural" (Walker, 1999: 215). She suggests that overall her findings indicate that socio/cultural factors influence conceptual development on a domain-by-domain basis.

Atran (1998), on the other hand, does not accept the importance of culture in the development of biological concepts. His comparative study indicates that adult Maya, Americans and scientists use similarly structured taxonomies for animals and plants. In view of his findings, Atran believes that "humans everywhere think about plants and animals in highly structured ways [which] are routine products of our 'habits of mind'" (Atran 1998: 574).

Atran's work appears to be a negation of the work of Hatano and his colleagues, but Hatano (1998) defends their position, noting that Atran's experimental materials were selected predominantly on linguistic grounds. Hatano suggests, therefore, that

Atran's findings could be based primarily on linguistic, rather than biological knowledge.

Coley (2000) contributes a different perspective on cultural influences in the development of biological concepts. He notes that the conceptual systems of adults are not all alike, as evidenced in the wide variability in their responses to biological questions. Therefore, he regards comparisons of the ideas of children with those of certain adults as problematic.

Cultural influences are a likely explanation for an age-related difference which has been found in children's responses to questions which require categorisation. This phenomenon has been found by Rosch and her colleagues (1976) in their investigations across several domains. They discovered that while children older than seven years of age sort objects on the basis of the taxonomic category of an object, younger children often sort objects on the basis of causal or temporal relations. For example, they asked children to sort common items such as people, animals, vehicles and clothes. Respondents older than seven years tended to group all the vehicles together and all the clothes together. Rosch and associates suggest this is because they perceive the perceptual or functional properties that the objects share. Younger children, on the other hand, often placed a boy, a coat and a dog together. This might be because the boy wears a coat when he takes the dog for a walk. However, Rosch and her colleagues found that when young children are specifically guided toward categoric relations they are able to demonstrate some understanding.

Rosch and associates (1976) allow that people of all ages are interested in thematic relations, but believe it is the way that children's attention becomes focused upon categorical relations which changes most with development. They assume that the influence of Western culture is responsible for this aspect of development. In fact, the findings of Rosch and colleagues may be a specific example of a wider range of developmental differences in categorisation. For example, according to Goswami (1998: 80), children may notice or emphasise *different* attributes of the same object more than adults do, so that "children's categories may thus be broader than, narrower than or overlap with, the corresponding adult categories").

Oakes and Madole (2000: 119), in reviewing the literature on infant categorisation research, note that "infants' use of information in categorisation is context-dependent" and suggest that "the role of contextual variation ... needs to be better understood". They argue that "infants can use only the information to which they have access in a particular task. ... for example, it seems likely that an infant who

has the motor skills to actually make things roll will use that information to form a category and an infant who is unable to make objects roll will not” (Oakes and Madole, 2000: 124). They advise a shift in the emphasis in future research, so that “by examining how experimental context facilitates or constrains infants’ formation or discovery of categories, we [will] gain a fuller understanding of the process of categorisation itself” (Oakes and Madole, 2000 125).

The conclusion to be drawn from these studies is that major aspects of children’s knowledge and understanding, such as that people, other animals and plants and inanimate objects are different types of entities, are widespread. Nevertheless, the influence of the socio/cultural environment is discernible in their developing ideas. In particular, information resulting from differences in the physical environment can result in differences in detailed knowledge whereas differences in religious beliefs can lead to differences in the interpretation of information.

3.5 Developmental research in cognitive neuroscience

Quartz and Sejnowski (1994: 726) suggest that constructivism can describe learning processes in terms of “structural growth mediated by environmentally derived activity”, but although many aspects of development in the nervous system have been charted by neuroscientists, it is only very recently that an attempt has been made to relate this knowledge to maturation in children’s behaviour.

The reason for this integrative delay, according to Rakic (2000a: 6), is that “perhaps there are too few ‘bridge people’ - people who can and will synthesise diverse information obtained from different levels of analysis”. In fact, Johnson (1999: 199) argues that the relative neglect of biological factors in the study of behavioural development is “somewhat surprising when one considers that the origins of developmental psychology can be traced to biologists such as Charles Darwin and Jean Piaget”. In agreement with Rakic, he suggests that the reason might be due to its intricate nature. Whereas in the development of other parts of the body an increase in size and specialisation are sequential events, controlled by a *genetically* driven process, brain development is an *epigenetic* process, “heavily dependent on complex interactions at the molecular, cellular, and behavioural levels” (Johnson 1999: 201). Therefore, contrary to the nativist view of development as something that just happens to a system, “neurobiology and computational modelling have come to recognise, as did Piaget, the importance of the active role of biological systems in development” (Quartz and Sejnowski 1994: 726). These ideas are developed below.

3.5.1 Domain-general changes during development

Despite the domain-specific findings of post-Piagetians reported in this chapter, it is also apparent that there is some truth in Piaget's assertion that there *are* ways in which young children think differently from adults. What is needed, therefore, is an account of "age-related, domain-general changes in reflection and the control of behaviour" according to Zelano (1994: 732). Evidence for such changes can be found in a study of the physical development of the brain.

Dendritic and synaptic connections among neurons

Modern textbooks on cognitive neuroscience (for example, Gazzaniga, Ivry and Mangun 1998) chart the normal development of the human brain. The most obvious is the increase in size and complexity of the branched dendritic connections which link neurones. Not only does the extent and reach of a cell's dendritic tree increase dramatically over time, it often becomes more specialised. As this takes place there is a corresponding increase in the number of synapses which form the physical junctions between neurones. Although research in rats indicates that this process is enhanced by the stimulus of a rich environment (Stevens 1996), "this mechanism is not supported by any study in primates, including humans," according to Bourgeois, Goldman-Rakic and Rakic (2000: 48). In fact their work on the development of the primate visual cortex indicates that synaptogenesis can proceed normally without visual stimulation or retinal input" (Bourgeois, Goldman-Rakic and Rakic (2000: 50).

Organisational changes

Organisational changes take place within the brain as well. An example at the cellular level is found in the visual cortex, which provides a clear illustration of brain development which is not a straightforward matter of progression from simplicity to complexity. The generation of synapses in this region begins at around the time of birth and reaches a peak at about a hundred-and-fifty per cent of adult levels toward the end of the first year. Thereafter, regressive events (pruning) stabilize the number of neurones and their connections to adult levels during later childhood. This is regarded as a gain for specialisation rather than an overall loss since it contributes to the sculpting of specific neural pathways. Therefore, although the human brain is regarded as having a good deal of plasticity, it is also the case that some maturational processes are irreversible.

Brain activity

Another change is that of brain activity as a result of learning. Posner and Rachle (1994) have used the positron emission topography (PET) procedure to demonstrate differences in active brain regions between a novice and an expert when carrying out a thinking task. They found that an expert uses a smaller region of the brain than a novice, indicating greater efficiency. However, although the active region in the expert has some overlap with that active in the novice, a small area of the brain that is active in the expert is not used by the novice, indicating that there is a qualitative change in the way the thinking task is carried out.

Myelinisation

A change in the nervous system as a whole is seen over many years in childhood. The nerve fibres become covered in a fatty myelin sheath which helps conduct electrical signals. This process is completed first in the sensory and motor pathways and last in the cortex. Gazzaniga, Ivry and Mangun (1998) suggest that the development of the myelin sheath is likely to be a causal factor contributing to the increasing efficiency of thinking processes during the early years of life. In fact, partial myelinisation may contribute to the age-related differences in working memory which have been recorded. For example, Swanson (1999) found that age-related performance differences supported a general capacity explanation. Early performance limitations reflected demands placed on “both the accessing of new information and the maintenance of old information” (Swanson, 1999: 986).

The frontal cortex

Different regions of the human brain mature at different rates. The frontal cortex is the last to mature. Here, Johnson (1997) describes detectable changes in synaptic density even into the teenage years. This area of the brain is considered by most investigators to be critical for many higher cognitive abilities. In particular, “this region has long been linked to the idea that it provides the neural substrate for a collection of higher-order capacities such as planning, reasoning, self-awareness, empathy, emotional modulation, and, especially, decision-making” (Tranel, Bechara and Damasio 2000: 1047). These attributes develop slowly, so that even in young children “early signs of competencies that will later be fully developed are already in evidence” (Bourgeois, Goldman-Rakic and Rakic 2000: 50). Therefore the relative immaturity of the frontal cortex is a likely factor in many of the differences in cognitive behaviour recorded in children of different ages. Indeed, it could well provide an explanation, in broad terms, for Piaget’s description of the development of reasoning abilities during childhood and adolescence.

The frontal cortex is associated with another function. This is the increasing voluntary control over the ability to inhibit a set of responses that are appropriate in one context but not in another. It was first noted by Leslie (2000) in relation to the idea of young children's 'theory of mind', but "inhibitory brain processes appear to be involved in other kinds of attention shifting" as well (Leslie 2000: 1242). Furthermore, "The frontal cortex plays an important role ... also in the retrieval of information from long-term memory" (Petrides 1994: 143).

Many aspects of learning are not domain-general, however. According to Cosmides and Tooby (2000b: 1164), "specialisation of circuitry often greatly increases computational efficiency, and endows architectures with the capacity to solve problems that could not be solved at all by general-purpose methods. Gallistel (2000: 1190) argues that "the only processes likely to be universal are the elementary computational processes for manipulating signals to accord with the laws of arithmetic and logic and for storing and retrieving the values of variables". However, Cosmides and Tooby (2000b: 1261) believe that "there is at least some evidence for the existence of inference systems that are specialised for reasoning about objects, number, the biological world, the beliefs and motivations of other individuals and social interaction" as well. In fact, Donald (1994) suggests that there are both domain-general and domain-specific processes at work in development.

3.5.2 The evidence for innateness

Neuroscience parts company with Piaget over his idea that virtually all knowledge is derived from sensory experience. Thus Gallistel (2000: 1190) argues that "despite long-standing and deeply entrenched views to the contrary, the brain no longer can be viewed as an amorphous plastic tissue that acquires its distinctive competencies from the environment acting on general purpose cellular level mechanisms". In fact, Neville and Bavelier (2000: 83) argue that "neurocognitive development relies on a dynamic and complex interplay between predetermined genetic events and environmental events".

Computer modelling

Computer modelling has been employed to investigate the idea that a genetic predisposition for the development of certain types of knowledge need not involve a large amount of prewiring.

Accepting that the nerve cell or neurone is the fundamental unit in learning and that the synapse provides the linking mechanism between neurones, it is possible to

construct a parallel distributed processing architecture which simulates these features. Dawson (1998) explains that each processing unit in the network is analogous to a neurone, and each processing unit is linked to other processing units in a way analogous to a synapse. Just as synapses can have different strengths, the processing units can be linked by different weightings. Just as neurones can receive either positive or negative impulses across a synapse, so the links between processing units in a computer network can be given plus or minus values. As a whole, the model is a multi-layered system that generates a desired response to an input stimulus. When it is given a learning task the computer is fed information (the input stimulus) and given feedback (in the form of further input) on the nature of its success in producing an appropriate output. The input stimulus is encoded as a pattern of activity in a set of input processing units. The response of the system is represented as a pattern of activity in the network's output processing units. Intervening layers of processors in the system, called hidden units, detect features in the input stimulus that allow the network to make an appropriate response.

Elman and his colleagues worked on computer simulations to provide an account of learning that is "broadly consistent with what is known about what genes do and how they work in other domains" (Elman, Bates, Johnson, Karmiloff-Smith, Parisi and Plunkett 1996: 18). They conclude that a great deal of information and structure is latent in the environment and so does not require innate knowledge in the brain. For example, it is known that the visual cortex includes neurones which are selectively sensitive to highly specific inputs. These neurones include edge detectors and motion detectors. Biologically plausible network models have been constructed which demonstrate that these properties do not have to be pre-specified. Detectors such as these emerge naturally and inevitably, as a function of a simple learning rule and exposure to stimulation.

Therefore certain problems in mental development have a natural solution, according to Elman and his colleagues, depending on the most minimal of inherited predispositions. "All that may be required are a few gentle nudges in the form of pre-wired biases and constraints" (Elman, Bates, Johnson, Karmiloff-Smith, Parisi and Plunkett 1996: 16).

Such minimal prewiring may be sufficient to resolve the question of innateness. In fact, Scholnick (1994: 728) cautions against the idea that much is pre-determined because it negates the idea of epigenesis, which would imply that mature mental structures are latent at birth.

CHAPTER 4

THE DEVELOPMENT OF BIOLOGICAL KNOWLEDGE AND UNDERSTANDING IN YOUNG CHILDREN: A REVIEW OF THE EDUCATIONAL LITERATURE

4.1 Introduction

Whereas developmentalists are concerned with the formation of mental structures or theories, educational researchers simply wish to discover pupils' knowledge and understanding in the belief that their findings will inform teaching. However, the findings of developmentalists are most relevant to an evaluation of the literature reviewed in this chapter. The purpose here is to evaluate what is known already about the development of knowledge and understanding in young children and to clarify an area which would benefit from further study.

4.2 Outline

The chapter begins by defining the scope of the review. This is followed by a discussion of the development of knowledge and understanding of biological topics in young children. Special attention is devoted to the work of Leach and his colleagues as it is particularly relevant to the topic of the thesis, the organic origin of food. Finally, the methods employed are evaluated and conclusions are drawn.

4.3 The scope of the review

The focus of this thesis is the development of biological knowledge and understanding in children aged from four to eight years. Consequently, studies which include children within this age range and which investigate changes in children's ideas over time were chosen for review.

Reflecting the topics found in the literature, this review is limited to educational research in the biological topics of the meaning of 'alive', the human body, and the nutrition and growth of animals and plants.

Table 4.1 provides a summary of the nine studies.

Table 4.1: The research reviewed

Author(s)	Year	Country	Age	Sample size	Topics
Contento	1981	New York, USA	5 - 11	34	Human digestion & nutrition
Francis & Hill	1992	Wagga Wagga, Australia	Y4/ Y8/ adult	62	Human nutrition
Gellert	1962	Massachusetts, USA	4 - 16	96	Human body
Leach Driver, Scott & Wood-Robinson	1992, 1995, 1996a, 1996b	Leeds, UK	4 - 16	70	Animal and plant growth & nutrition
Magarey, Worsley & Boulton	1986	Adelaide, Australia	7 - 10	222	Human digestion & nutrition
Osborne, Wadsworth & Black	1992, 1994	London, UK	5 - 11	75	Human body, digestion & nutrition, the meaning of 'alive'
Russell & Watt	1990	Merseyside, UK	5 - 11	60 (approx.)	Plant growth & nutrition
Teixeira	2000	Brazil	4/ 6/ 8 / 10	45	Structure & function of the digestive system
Wellman & Johnson	1982	Pittsburgh, USA	6/ 9/ 12	15/ 15/ 15	Human nutrition

The research was conducted with children in different parts of the world: Brazil, the United States of America, Australia and England. There is a span of thirty-eight

years between the earliest and latest of the studies. Only two have been found which investigate children's developing knowledge and understanding over a wide age range, enabling (through a comparison of children from four to sixteen years) the identification of persistent misconceptions. These are Gellert's (1962) study which describes American hospital patients' ideas about the human body, and Leach, Driver, Scott and Wood-Robinson's (1992; 1995; 1996a; 1996b) work which gives an account of English school pupils' ideas about plant nutrition.

Two studies were conducted by health professionals. The first is Gellert's (1962) work, which was conducted with the purpose of informing those medical practitioners who wish to explain to children the nature of their illness and its treatment. The second is that of Magarey, Worsley and Boulton (1986), which forms part of a larger research project about the growth and nutrition of a cohort of normal children since birth. The other studies are all school-based. Those conducted in the UK were commissioned in connection with the introduction of the National Curriculum for Science in England in 1988.

4.4 Findings

For the reasons described above, the subjects of these studies had different experiences in education, culture and life events. The review is therefore concerned with the patterns in the data: the changes which occur in children's knowledge and understanding over time rather than the exact age at which a change might be expected. Contento's (1981), research into the development of children's understanding of digestion employed Piaget's developmental stages as the theoretical framework. Consequently, the children in her study are described as either preoperational or concrete operational instead of by chronological age.

It has been customary for educational researchers to use empirical findings to catalogue those ideas of pupils which are scientifically accepted and to identify misconceptions which should be corrected. In fact, a more discriminating analysis allows two other patterns to be identified. The first of these is that some responses given by young children are different in kind from those of older subjects. However, it is important to recognise that, unlike the persistent misconceptions which concern teachers of adolescent pupils, these responses disappear with age and do not require the attention of teachers. The second pattern worthy of attention is that different cues may elicit different aspects of a child's knowledge within the same domain.

4.4.1 The meaning of the word 'alive'

Of the research reviewed in this chapter only one small piece addresses a biological topic featured in chapter three. This is Osborne, Wadsworth and Black's (1992) adaptation of Piaget's question about the meaning of the word 'alive'. Children were asked to say whether a list of ten objects (a plastic box, a small piece of rock, a spoon, a plant, an animal, an insect, an apple, a toy car and a seed) were living, once living or had never lived. Notwithstanding the similarity to Piaget's questions put to the children, the purpose of the enquiry was different. Osborne and his colleagues (1992: 43) explain that "the main interest in this work was to use such a question as a means of eliciting children's biological knowledge and not as a means of exploring the causal reasoning of children". Be that as it may, their description of the research instrument employed is tantalising. The reader is left to guess what sort of 'animal' the researcher had in mind since 'an insect', as a different entity, is placed adjacent in the list of objects to be described. Further curiosity is aroused as the authors state that "the range and diversity of children's response to this question provides a fascinating insight to children's thinking" (Osborne, Wadsworth and Black 1992: 43) but then provide the responses of only three children. Despite the different purpose of this study from that of Piaget, the responses to Osborne and his colleagues' questions bear a striking similarity to those reviewed in chapter three in that the youngest child, a five-year-old, made statements which are different in kind to those made by older children. For example, a plastic box was described as not alive "because it hasn't got a face" and an apple as not alive because "you have to eat it". On the other hand, unlike many of the young children in Carey's (1985) studies who did not credit plants as being alive, the five-year-old cited in Osborne, Wadsworth and Black's study explained that a plant was alive because "it grows and grows", showing knowledge that it had an attribute of living things.

4.4.2 The development of factual knowledge

As expected, increasing scientifically correct factual knowledge was demonstrated as children grew older, although at every age there were examples of incomplete and mistaken ideas. Some examples of all three types of response are described below.

There was not a great variety in the responses given by children to each probe or question. Rather, "in each topic, the statements revealed a rather limited number of diverse conceptions" (Gellert 1962: 389). Gellert notes that this was especially true of the oldest group she studied, where responses tended to be rather uniform.

Nevertheless it was impossible to predict the state of knowledge of any individual within a particular year group. This is because, as Magarey, Worsley and Boulton (1986: 15) remark about the children they interviewed, “a wide range of concept development was found in all ... groups”.

Knowledge about the human body

Scientists regard the human body as a complex system of organs, each with one or more distinct functions, but Gellert (1962), who employed both drawings and questioning, found that some children below the age of seven years could not think or reply in terms of their bodily content at all. Those younger children who could do so listed items largely in terms of what could be observed going into or coming out of the body. However, there was a sharp rise in the information offered between the ages of eight and ten years, although children were sometimes incorrect about the position and size of internal organs. Many believed that whereas the contents of the trunk (with the exception of the appendix) were indispensable, the extremities were less essential. A number correctly regarded one of a pair of organs to be sufficient for maintaining life. As might be expected from hospital patients, many of the items mentioned by the subjects of Gellert’s study were related to pathology.

Osborne, Wadsworth and Black (1992) found a similar increase in correct factual knowledge with age. Children aged five to seven drew fewer items on a body outline than older children, aged seven to eleven years. Predominantly, these items included the heart, bones, stomach and brain. As in Gellert’s study, the younger children were uncertain of the correct position of the organs.

Knowledge about nutrition and growth in animals

Osborne and his colleagues (1992) found that five- to seven-year-olds naïvely regarded most items in their diet to be healthy, whereas older children were better able to discriminate between healthy and unhealthy items. Contento, too, discovered that less mature (preoperational) children did not draw a distinction between healthy and unhealthy components in their diet, categorising all edible items as food. Furthermore, most of the children in Contento’s study demonstrated the somewhat mistaken view that vitamins were pills that made people strong and healthy.

In response to their ‘scene’ probe, Leach and his colleagues (1992) found that there was a general trend with increasing age for pupils to be more specific about the food sources available to particular animals. Many younger pupils thought that all living organisms are fed by people, and others thought that animals “could eat just about anything, depending on what was around” (Leach, Driver, Scott and Wood-

Robinson 1992: 67). Older pupils were more likely to be aware that particular animals have distinct dietary requirements and cannot easily change their source of food.

Knowledge about nutrition and growth in plants

This is a topic of particular relevance to the present thesis. Children who had grown their own bean seedlings in soil were asked in Russell and Watts' (1990) study, "What do you think the plant needs to help it to grow?" These researchers received many correct responses, which increased in frequency with age. Water or moisture were mentioned most often at all ages. The next most common item was the need for a substrate in the form of soil, compost or sand. This response was suggested by nearly a third of the younger pupils and fifty-six per cent of the nine- to eleven-year-olds. The sun was mentioned by a quarter of those aged five to seven years, but rather less often by older pupils. On the other hand, warmth was indicated by only five per cent of five- to seven-year-olds, thirteen per cent of seven- to nine-year olds and thirty-nine per cent of nine to eleven-year-old pupils. Similarly, light was suggested by only a few younger pupils and by rather more (twenty-two per cent), of nine- to eleven-year-olds. 'Plant food', minerals or fertiliser were mentioned infrequently. With respect to the plants' need for gases, none of these children, aged five to eleven, mentioned carbon dioxide. Of the nine- to eleven-year-olds, twenty-two per cent mentioned air and eleven per cent mentioned oxygen.

A few of the older children thought that darkness promoted growth. Russell and Watt suggest that the reason for this mistaken idea was probably their observation that increased stem length is promoted by the absence of light. Another incorrect response given by a few older children was the idea that creatures either in or above the soil were needed for plant growth. In addition a third incorrect response, given by a few older children, was that plants grow best in cool conditions.

Leach and his colleagues (1992) obtained similar findings in response to their 'scene' probe. When asked to say what a tree needs to stay alive and healthy, sixty-four per cent of children aged four to six years demonstrated awareness that plants need water but few mentioned soil or sunshine. No other needs were mentioned. In contrast, when correct items were suggested for confirmation, all subjects aged eight and above agreed that soil, water and sunlight were necessary for plant well-being. Only a few older pupils, aged eleven to fourteen, mentioned carbon dioxide, whereas after teaching many older adolescents referred to photosynthesis in some way.

When asked about the growing bean, “Where do you think the leaves have come from?” Russell and Watt (1990) discovered that incomplete knowledge decreased slightly with age. For example, the statement “from the bean” was offered by several pupils at all ages from five to eleven. A similar response indicating incomplete knowledge was simply that the leaves came from inside the bean. However, this slightly more insightful reply increased with age, from a quarter of infants to just over half of the older pupils. As the age of the children increased, so did the number who mistakenly stated that new material for the growing bean came from other parts that already existed. A correct response, indicating the intake of minerals, was given by only nine per cent of infants, who expressed the opinion that new material for growth came from under the ground, while a few older children mentioned soil, minerals or compost. The most important component of new plant material, the gas carbon dioxide, was unknown to younger subjects. Even in the oldest group in Russell and Watt’s (1990) study, only six per cent of nine to eleven year old children mentioned air or gases. Only one eleven-year-old, who attributed her knowledge to books, made correct reference to three materials from outside the bean being incorporated to form the leaves and stem: “From the soil. From water. From the air outside. That’s it.” (Russell and Watt 1990: 44).

Discussion of the origin of factual knowledge

In confirmation of the developmental work reviewed in chapter three, it can be seen that even the youngest children displayed an impressive amount of correct factual knowledge. As well as this, incomplete and inaccurate statements in younger subjects gave way to more detailed and correct descriptions in older children. Two sources of information are commonly suggested by the authors of these studies: sensory experiences of the material environment and mediated experiences provided by the cultural environment. An account of current ideas of the processes involved in learning in both of these ways is provided in chapter two.

a) sensory experiences

That sensory experiences make an important contribution to factual knowledge is indicated in the following statement: “As the large bones of the body can be felt by their owners, it is not surprising that they were the most frequently mentioned part of the body” (Gellert 1962: 349). It follows that body parts which provide the most conspicuous sensory experiences and whose sensations occur most frequently, will engender knowledge in the youngest subjects. In support of this view, Gellert explains children’s early knowledge of the stomach and digestion in this way:

The digestive tract is filled and emptied relatively voluntarily by almost every child. It is a frequent source of intense sensations and of psychological associations. Its function receives much attention in the course of growing up. Certainly, the pleasures of satiation and the discomforts of hunger or digestive disorders are experienced almost universally from babyhood on.

(Gellert 1962: 363)

In contrast, less accessible or ambiguous perceptions are assimilated at a later age. For example, an explanation of the widespread ignorance of the liver is that “this large, vital, and most complex organ normally functions without conscious awareness or participation” (Gellert 1962: 375).

Similarly, many children in Osborne, Wadsworth and Black’s (1992) study give incorrect information about the size and/or location of internal organs. The researchers find this unsurprising, “since internal organs by their very nature are not visible or available to touch. Therefore it is difficult for a child to develop a knowledge of an object which can only be partially sensed” (Osborne, Wadsworth and Black 1992: 31).

Nevertheless, it is not always clear how children interpret their sensory experiences. Gellert could not find a consistent relationship between frequency and size of the sensations from the organ or its perceived importance on the one hand, and an exaggerated size in the drawing of that organ on the other: neither could she find that ignorance of function produced a greater number of children’s ideas about it.

A further suggestion considered by Gellert (1962) might be that children explain familiar phenomena naturalistically and strange phenomena non-materialistically through magical, supernatural, and animistic statements. However, she could not find support for this idea in her data.

b) cultural mediation

The origin of children’s knowledge cannot be explained solely in terms of sensory input. Secondary sources, whether through the media or personal interaction, can mediate learning. It will be recalled that in chapter three Hatano and his colleagues (1993) suggested that television and magazines were a source of children’s knowledge. This is so obvious that it is more frequently acknowledged as a source of *misunderstanding* than in its regular function of imparting correct information. For example, Osborne and his colleagues found that over two-thirds of all children drew the heart as “a valentine shaped object” and a similar number of seven- to eleven-year-olds placed it on the left of the body rather than in a central location.

These authors point to the overwhelming number of everyday images which erroneously represent the heart in this way, and suggest that seven- to eleven-year-olds, even more than five- to seven-year-olds, are influenced by such images. Personal interaction, too, while recognised as a powerful source of accurate information, can give rise to inaccurate responses by children. This is illustrated by a tendency in young children to draw two tubes leading from the mouth to the stomach: an incorrect idea for which the everyday saying, "It's gone down the wrong way," reinforces the concept of two tubes implying that there is more than one way for food or drink to pass through" note Osborne, Wadsworth and Black (1992: 39).

However, of the information available to children, from whatever source, "only selected facts were assimilated from among those that presumably were available to the children. External circumstances can be effective only when the mind has developed to a stage at which it can profit by them" (Gellert, 1962: 391).

4.4.3 The development of understanding

As reported in chapter three, Gelman (1990) argues that: "the young focus on and use relevant aspects of the environment because their behaviour and their assimilation of information are guided by mechanisms that embody implicit domain-specific principles" (Gelman 1990: 80). For example, she suggests that organising mental structures relating to living things:

operate on, and therefore render salient, information that pertains to the fact that animate and inanimate kinds start, continue to, and stop moving in different ways. Children can develop quickly a coherent data base or body of knowledge about the animate-inanimate distinction because it is rooted in an available structure that defines relevant inputs and assimilates cases of these to a nascent skeletal structure.

(Gelman 1990: 91)

Thus although factual knowledge may accumulate without understanding, the organisation of this knowledge into coherent structures is the key to sound learning. Detailed in this section are some explanations put forward by educationists for their findings in relation to the development of understanding.

Understanding about the blood system

The majority of Gellert's subjects understood the heart to be the most important part of the body because of its part in 'running' vital processes, and "the dire

consequences of having it stop beating were known to many” (Gellert 1962: 335). Over half of the younger patients mentioned blood in relation to the heart whereas many older children mentioned circulation as well. Some understood that the heart pumps blood, but none mentioned blood returning to the heart.

In confirmation of Gellert’s findings, Osborne, Wadsworth and Black found that whereas most of the younger children (aged five to seven years) could only say that the heart beats, many older subjects (aged seven to eleven years) could explain that it pumps blood.

Understanding about the respiratory system

Gellert (1962) found that only by the age of nine or ten years could most subjects associate the lungs with breathing and not until the age of fifteen years were subjects aware that lungs are essential for life. Similarly, Osborne and his colleagues (1992) discovered only one eleven-year-old girl, one of the oldest in their sample, who could demonstrate an understanding of gaseous exchange. She stated, “Air comes down and carbon dioxide comes out.”

Understanding about digestion

The fact that the stomach has some relationship to eating food was understood by most children, Gellert found, although the process of change or transformation of food in the stomach was only mentioned first at the age of eight years. Not until the age of eleven years did the majority consider aspects of digestion a function. The two main (correct) ideas expressed were that food goes to various body parts, and that food is discharged. However, many younger children in both Gellert’s (1962) and Teixeira’s (2000) studies simply suggested that food keeps dropping downwards as far as it can go.

Magarey, Worsley and Boulton (1986) found that most seven-year-olds could only give an anatomical response to the question, “What happens to food after we eat it?”. Examples of these replies are that it “goes to the neck,” or “goes into the stomach” (Magarey, Worsley and Boulton 1986: 12). In contrast, just over half of the ten-year-old children gave a response which indicated utilisation or digestion and excretion of food. For example, “It is digested,” and, “Good parts go into the blood, bad parts go into the toilet” (Magarey, Worsley and Boulton 1986: 12).

The fact that food is ground or chewed in order to make it smaller was mentioned quite frequently by children in Gellert’s study but from the age of eight years upwards did such statements as “food is dissolved” or “turns into liquid” began to

appear increasingly. However, whereas to a number of children the word *digest* apparently meant that food “settles”, “calms down”, “rests” or “becomes stored” (Gellert 1962: 73), more frequently a dynamic conception seemed to prevail. For example, one child stated that “food is churned” (Gellert 1962: 373).

Only six children, all over the age of eight in Teixeira’s (2000) study, involving forty-five children, indicated that there are substances in the body that can modify others. However, Gellert (1962) found that in addition to the stomach and intestines, the heart, glands, liver and pancreas were mentioned by some children as being instrumental in digestion. Scientifically, of course, all but one of these items do indeed have a part to play in the process of digestion (the heart does not).

Contento found that the preoperational (less mature) children in her study believed that food goes into the stomach and stays there unchanged or else somehow goes to the tissues in unchanged form. In this case there was no recognition of any fundamental transformation of the food or its assimilation into the body. In contrast, all but one of the concrete operational (more mature) children understood that food is changed in some way in the stomach. However, concrete operational children differed in what they thought happened to food on leaving the stomach. Only forty-two per cent understood that food is transformed before bringing about its desired effect.

If elimination of waste was not mentioned spontaneously, Gellert (1962) asked whether food ever comes out anywhere. She found that some of the younger children revealed scientifically incorrect ideas about this. Forty per cent of children under the age of eight years denied the evacuation of food. Thirteen per cent said only “when you throw up”, whereas ten per cent mentioned both oral and anal orifices. On the other hand, above the age of eleven years no child suggested vomiting as a way for disposing of ingested food. Although some younger subjects referred to the intestines, it was not until fourteen years of age that the majority of Gellert’s subjects correctly reported that food passes from the stomach through the intestines on its way to being eliminated.

Understanding about nutrition and growth in animals

At all ages, some children in Gellert’s (1962) study correctly understood that food helps them grow or that food makes, turns into, or enters the blood. Similarly, Both Contento and Magarey, Worsley and Boulton (1986) found no great developmental differences in children’s response to questioning about why we need food. In

general, children gave a mechanistic response such as, “we eat to be healthy” (Magarey, Worsley and Boulton 1986: 11).

In Francis and Hill’s (1992) study there was broad agreement among pupils and parents that vegetables, fresh fruit, chicken and bread are foods which are important in the human diet and needed for growth. However, there was no understanding shown at any age about how much of these foods is needed or why they are required. Ice cream, lollies and cake were classified as food more often by school pupils than by adults, although older pupils and adults correctly recognised these items as a source of energy. Francis and Hill believe that the youngest pupils reasoned differently from older subjects. For example, one stated that watermelon was a fruit so it was good for you and so it must give you lots of energy, while sugar was bad for you so it can’t give you much energy.

Unlike the other research reviewed in this chapter, which is based upon semi-structured interviews, Wellman and Johnson (1982) employed two convergent judgement tasks in order to probe children’s developing understanding about nutrition. The first was designed to test children’s ideas about the nutritional inputs of a pair of characters. By showing the children pictures of two characters who differed in one dimension on each occasion, they were able to investigate the perceived cause of differences in weight, height, health, strength and energy. The second task focused upon children’s ideas about the consequences of variations in certain nutritional inputs. Here children were presented with pictures of identical twins and asked to judge whether differing future diets would result in differences between them. The vast majority of children considered health and vitality to be food-related. However, the older children understood that the quality of the food eaten, as opposed to the quantity, was the crucial factor in maintaining health, increasing strength, and in accounting for energy levels. Six-year-olds, and to some extent nine-year-olds, mistakenly believed that increase in the amount of food ingested would lead directly to gain in height and weight. On the other hand, whereas every twelve-year-old correctly related the quantity of food eaten to the difference between the fat and skinny child shown in the pictures, eighty per cent realised that heredity was responsible for most variation in height. At all ages children understood that a diet of one input alone (such as water, beans or candy) would have serious negative consequences.

Although in Leach, Driver, Scott and Wood-Robinson’s study a large number of pupils said that food is the main source of matter for animal growth, “the majority of responses at all ages suggested that pupils had no idea that ingested matter is

transformed to body matter” (Leach, Driver, Scott and Wood-Robinson 1992: 103). This finding is confirmed by Russell and Watt who, when they asked about the needs of caterpillars, discovered that although feeding was the most common condition associated with growth, “no children offered anything like a conventional biological explanation of animal growth involving incorporation and transformation of material” (Russell and Watt 1990: 91).

Understanding about growth and nutrition in plants

When asked about a germinating bean seed, “What do you think is happening inside the bean?” Russell and Watt (1990) found that the most common reply was that enlargement by increase in mass, volume or size was occurring. This type of incomplete response was most common among younger subjects. As an explanation for the enlargement, many could only identify water was the source. Actions rather than nutritional or developmental sources, such as “straightening”, “uncurling” and “pushing” were mentioned by many children above the age of seven. Indeed, “it has to be acknowledged that the description of how growth occurs might well be found a challenge by many adults,” concede Russell and Watt (1990: 46).

With regard to photosynthesis, the process by which plants make their own food from carbon dioxide and water using energy from sunlight, Leach and his colleagues (1992) found a widespread lack of understanding. Even the oldest pupils (aged sixteen years) were unable to demonstrate a scientific understanding of the relationships among energy, photosynthesis and the need for carbon dioxide and water, in response to their ‘eat’ probe.

Discussion of the growth in understanding

Beliefs regarding the nature of intellectual development vary in the explanations suggested by the researchers for their findings. Therefore working in an era before it was widely questioned, Contento relies upon the Piagetian idea of intellectual stages to argue that “these findings are not surprising from the point of view of developmental theory. Nutrients are abstract concepts. Studies have shown that formal operational thought is correlated with the ability to understand abstract concepts in science” (Contento, 1981: 89).

In denial of domain-general stages, Gellert’s (1962) explanation is more in line with contemporary thought. She argues that “cognition undergoes qualitative as well as quantitative changes in the process of development” (Gellert 1962: 400). Leach and his colleagues (1996a: 30) suggest that “a feature of the responses of older students

was the number of possible factors mentioned in explanations, and the way these factors were linked together". These improved mental connections enable better explanations to be made:

While (with some exceptions) the younger ones based many explanations upon *external relationships* and accidental, or purely superficial analogies, the more mature children generally were more able to think in terms of higher order, general principles.

(Gellert 1962: 397-8).

When interpreting children's developing understanding of nutrition, Wellman and Johnson propose a three-stage, domain-specific model of development in children's understanding:

Knowledge about nutrition, ... can be thought of as composed of three related accomplishments; (a) knowledge *of* a variety of relevant nutritional inputs and outputs; (b) knowledge *that* the inputs are functionally related to the outputs; and (c) knowledge of how inputs relate to outputs, i.e., knowledge of nutritional relationships and processes.

(Wellman and Johnson 1982: 146).

They regard the greatest age-related change to be that of understanding how inputs relate to outputs. These authors argue that:

what distinguishes the understanding of older children is their ability to construct a more integrated model of how different nutritional factors interact with each other and with various other factors in the human physiological system. This involves specifically the development of knowledge about an invisible system, or inferred set of relationships which go beyond surface or apparent similarities.

(Wellman and Johnson 1982: 46).

When examining responses to questions about the interdependence of living organisms in a food chain, Leach and his colleagues (1996b: 137) suggest that "the explanations of younger pupils seemed to draw upon a form of linear causal reasoning," whereas older pupils, were more likely to use information in a more interrelated way. They also note that "between the ages of five and seven, many pupils think of organisms as individuals rather than as members of a population" (Leach, Driver, Scott and Wood-Robinson, 1996b: 138).

However, in none of the studies reviewed here did the researchers refer to the development of an overarching theory as did the developmentalists of chapter three.

4.4.4 Persistent misconceptions

Whereas it is customary to place emphasis upon misconceptions in studies of pupils in their adolescent years, incorrect responses given by very young children are often simply interpreted as an indication of incomplete knowledge. However, there are some mistaken ideas recorded in young children which do not disappear as knowledge increases with age. This becomes apparent when their responses are matched with the alternative conceptual frameworks of adolescent or adult learners. For example, in Francis and Hill's (1992) study, children did not consider fluids (with the exception of milk) to be foods. This misconception persisted, so that few adults considered alcoholic beverages as a source of energy.

Another example is the well-known persistent misconception recorded by Leach and his colleagues (1992). They asked children where all the extra 'stuff' has come from when a seedling grows into a tree. The vast majority of pupils, at all ages from four to sixteen years, referred to water as the single source of matter for growth in plants. Above the age of eleven years, increasing numbers of pupils stated that growth results from soil and the sun. Nevertheless, only a small number of the adolescent pupils (who had all been taught about the process of photosynthesis) accepted the idea that plants make their own food. This minority remembered that atmospheric gases are a source of matter for plant growth. Therefore it seems that the origin of this misconception, which occurs in very young children, persists in the majority of adolescents: they do not accept that plants utilize gases from the air in the process of growth. Furthermore, the misconception is maintained in spite of appropriate teaching.

Discussion of the origin of misconceptions

Both of the misconceptions mentioned here are related to scientific ideas which are counterintuitive. That is, they appear to contradict the evidence of the senses. For example, since alcohol is a liquid it is equated with water (which does not have a calorific value) rather than to nutritious food (which is normally solid).

The process and outcome of photosynthesis is counterintuitive as well. It is not surprising that children think only of water in relation to the needs of plants. As Russell and Watt (1990: 46) comment, "in tending the seeds and young plants, the provision of water would have been children's major involvement". Leach and his colleagues (1996a: 32) explain that even with adolescents: "pupils found it difficult to conceptualise plant body mass as coming from an invisible atmospheric gas and

water, rather than a more 'solid' substance such as soil". These authors omit to mention the contribution of energy from sunlight, which is another feature of photosynthesis that is difficult to grasp.

Of course it is reasonable to argue that young children cannot be expected to comprehend an abstract concept which presents a challenge to older learners. The point to be made here is that there is no discussion of learning experiences and resulting knowledge of young children in the literature, even though the research findings show that the foundation for these two misconceptions is laid at an early age.

In point of fact, the developmental literature reviewed in chapter three makes no mention of persistent misconceptions. This is hardly surprising since the emphasis there was upon those alternative ideas held by young children which *do* disappear with age.

4.4.5 Intriguing responses in younger children

On several occasions the youngest children made statements which are different in kind to those given by older children or adults. For example, many of the younger children in Osborne, Wadsworth and Black's study simply drew unchanged pieces of food inside the body outline when asked about the fate of items that are swallowed. This response would be surprising if given by an adult. However, some who did this also stated that "it [the food] goes into the blood" (Osborne, Wadsworth and Black 1992: 37), indicating that their knowledge might not be as incomplete as their drawings suggest. Further examples are to be found in Contento's work. One of her subjects said, "Food can't go anywhere; it doesn't have legs" and others talked about food going into the arms and legs as "little pieces of spinach" or "little pieces of carrots," and one child described food being transported to other parts of the body as "small ants" (Contento 1981: 88). These responses would be surprising if given by adults.

Another type of response which would be surprising if given by an adult is that twenty-four per cent of Leach Driver, Scott and Wood-Robinson's subjects aged four to six years believed that plants need human intervention to provide them with either food or water.

According to the data provided in the reports, these statements disappear without the aid of teaching as children become older.

Discussion of the origin of intriguing responses

The research reviewed in chapter three arose from Piaget's observation that young children make statements which are different in kind from those of older children and adults. In the light of the large number of findings reported by developmentalists it seems strange that only a few are recorded by educationists. Indeed, it may be conjectured that close examination of the transcripts resulting from the educational studies would reveal many more such statements which for various reasons have been overlooked or discounted. After all, they are easy to dismiss as being childish, unintentional, or the result of confusion.

Several explanations can be offered for the examples that are recorded. The first, a drawing of unchanged pieces of food within the body cavity, may simply indicate a young child's limits of graphic expression. Some of the statements reported by Contento may indicate the use of metaphor. For example, particles of food moving "as small ants" might be an attempt to liken them to the smallest entity the child knows which can move things from one place to another. However, the idea that wild plants depend upon humans for their water may be interpreted in different ways. At one extreme it could be seen as a sign of Piaget's 'egocentric' stage in development. At the other extreme, it might be simply a lack of experience of the world. Further questioning of the children would be needed to decide which explanation is best.

4.4.6 Inconsistent responses

Leach and his colleagues and Osborne and his colleagues, whose studies both employed more than one probe in connection with a single science concept, note that children's responses are sometimes inconsistent from one probe to the next. In fact, "Most pupils between the ages of five and sixteen are inconsistent in the form of explanation used in different contexts" note Leach Driver, Scott and Wood-Robinson (1996b: 138).

Contento (1981), too, was interested to discover inconsistent responses. She believes they indicate a conflict between theoretical knowledge and life decisions. For example, one child who had previously expressed understanding that sugar was bad for teeth, said that if he had fifty cents to spend he would buy candy. The sweet would not spoil his teeth, he said, "because I like it" (Contento 1981: 89). In fact, when offered a snack at the conclusion of the interview, almost all the children chose one from the foods they knew to be less nutritious. Even a nine-year-old, who

had described in some detail his visit to the dentist and the pain he had experienced there, showed ambivalence over which snacks to choose.

Discussion of inconsistent responses

The authors of the research reported here do not attempt to explain these inconsistencies. Be that as it may, the contents of memory are brought into conscious mind by cues or prompts, as explained in chapter seven. If the questioning described in the studies reviewed here can be regarded as memory cues, then each will trigger a group of related pieces of knowledge. However, the relationship among the pieces of knowledge perceived by the questioner may not be the same as that perceived by the respondent. Therefore cues, which to the questioner appear to be related to the same domain, may in the respondent trigger a different collection of knowledge items. These may either partially overlap the first or may be altogether different.

Another reason why one cue may trigger a different response from another is that the number of relevant items held in memory store may be more than the conscious or working memory can deal with at any one time. Therefore on the occasion of each cue only part of the knowledge available can be expressed. So each time a question is posed, only part of the memory store is retrieved, and this might be the same or different each time it is triggered. However, if this explanation is correct, it is an indication that the collection of knowledge items has not been integrated into a coherent whole. This is more likely to occur in younger subjects.

Lastly, it is possible that the respondent holds more than one concept relating to the memory cue. As explained in chapter two, it is not uncommon for a learner to hold both a scientific concept and a 'common sense' concept in explanation of the same phenomenon. The science concept may be in operation only in laboratory situations whereas the 'common sense' one is active in everyday life.

4.5 The research methodologies

In this part of the chapter the methods of the studies reviewed are evaluated in order to inform the empirical work of the thesis.

4.5.1 The design of the studies

All of the studies reviewed in this chapter involve a cross-sectional design. It was commonly employed in the developmental studies reviewed in chapter three as well.

This means that at least two cohorts of children at different ages were assessed at the same time, and as a result the cohorts differed in age. Hartman and George (1999: 137) caution that although it is tempting to attribute the difference in performance of these cohorts to age or development, the same variation could be attributed to cohort differences such as genetic or environmental variation.

The most striking genetic variation within any human population is that of gender. Furthermore, that there has been a large gap in performance in science between adolescent girls and boys is well known (for example, Harlen 1993). Therefore it is expected that educational studies will include similar numbers of both in each matched cohort.

Even within a single country, the socio/cultural environment is not the same for all children. This was brought to the attention of educators in England through the Plowden Report (Department of Education and Science, 1967), where social class was identified as an important variable in educational achievement. A major intervention, designed to assist pupils in areas of educational priority (in which the present author participated), is outlined in the Halsey Report (Department of Education and Science, 1972). However, it has proved difficult to bring about change. Solomon (1993b), who conducted a research project on how social deprivation can affect science teaching, asserts that "it is incontrovertible that poor social conditions of various types do diminish the capacity of pupils to profit from their schooling". Therefore it is customary to take account of the social composition of any experimental groups when undertaking research.

Hartman and George (1999: 138) suggest that "at best, the variables of cohort, age, and time of assessment are *proxy* variables for the real causal processes that operate in time". Thus when drawing conclusions "the resulting data do not lend themselves to strong causal inferences regarding the effects of age, cohort, or time of assessment" (Hartman and George 1999: 138). In fact, studies such as that of Leach and his colleagues employed cohorts which each encompassed a wide age span (for example, five to seven years and eight to eleven years) with no age gap between. This factor makes it difficult to identify age-related differences.

Longitudinal designs, on the other hand, involve the repeated assessment of the same individuals at different points in time. Although in principle they appear appropriate for studies of development they are impractical due to the time span available. As with cross-sectional studies, the assumption is that any differences in the results are due to age. Be that as it may, Hartman and George explain that

longitudinal designs confound age and time of assessment and are nonexperimental with regard to these two variables. Thus, "the causal variables may be events such as a turndown in the economy" (Hartman and George 1999: 138).

Notwithstanding these reservations, both types of design are profitable in an initial study of development because "although these simple designs suffer from a variety of interpretative problems, they provide valuable information. ... Once such a discovery has been made, the search for an explanation - the underlying process responsible for the finding - can begin" (Hartman and George 1999: 138).

4.5.2 The research instruments

The research reviewed in this chapter was primarily designed to elicit children's pre-existing knowledge about science. However, the instruments employed were unprecedented in the child's experience. Thus, contrary to the intention of the researchers, the long-term, stable features of children's knowledge may not have been revealed. Claxton (1993: 59) argues that "establishing content through experimental enquiry is inherently problematic".

There are methodological implications for a constructivist view of knowledge in research as well. The reason, according to Johnson (1996: 59-60), is that "Since each person makes his or her own sense of the world, and can only use what he or she already knows to do this ... it follows that ... there is an in built uncertainty in any communication between two individuals". He explains that "in applying this notion to the process of eliciting children's ideas, ... the translation interface is traversed twice, ... [and] at each 'translation' differences could arise" (Johnson 1996: 60-1). By this he means that firstly, "the child could be answering a different question to the one the researcher thinks he/she has asked" (Johnson 1996: 61). Moreover, "at the second crossing, the researcher could interpret the child's expression in a way that was not the meaning of the child" (Johnson 1996: 61). Thus for every exchange in a questioning procedure, each participant has to construct meaning for the statement of the other person. Johnson concludes that "efforts should be directed at the development of 'neutral ground' between researcher and child" (Johnson 1996: 62). By this he means ground that is accessible to both participants and does not in itself significantly constrain thinking and possible responses. Siegal provides emphasis for this point by stating, "the consequences of children's inexperience in constructing models of the experimenter's intent are serious, and mislead adults to tap into a fraction of their understanding" (Siegal 1991: 127).



Even more challenging than tapping into children's factual knowledge is the task of probing their understanding. This is because "with more complex or multi-dimensional attributes such as understanding, that are much more difficult to define, it is not easy to determine what constitutes a valid test" (White and Gunstone 1992: 178). There are different types of component involved in the construction of understanding. For example, although on the whole, the more the person knows about a concept the better the understanding, it is also possible that "someone might believe lots of propositions that turn out to be false" (White and Gunstone 1992: 91). In accordance with Piaget's advice for interpreting data, White and Gunstone recommend that the structure of a person's knowledge should be examined by looking at the pattern of associations between the various statements: "Are they inter-linked, or are they isolated, individual statements? The more extensive the interlinking, the better the understanding" (White and Gunstone 1992: 93).

All of the studies reviewed in this chapter (except Wellman and Johnson's convergent judgement tests) engaged individual children in semi-structured interviews in order to probe their knowledge and understanding. In fact, several of the authors (Leach, Driver, Scott and Wood-Robinson 1992 & 1995; Osborne, Wadsworth and Black 1992; Russell and Watt 1990) acknowledge Piaget's clinical interview as influential in the design of their research instrument. They conform roughly to Piaget's pattern: a problem is set, sometimes involving the manipulation of objects, followed by the experimenter probing hard to get at the thought processes underlying what children say or do. The outcome is a descriptive account of children's responses. Although Osborne (1994) describes this as phenomenology, there is a certain ambiguity in the classification of the products of these studies. For example, Tesch (1990: 93) describes the result of phenomenology as a description of the constituents of "the particular human experience that is being studied", but in the studies reviewed here the phenomena are children's ideas rather than experiences. In fact she suggests that when dealing with language as communication, "the type of research that has traditionally used this approach is known as content analysis" (Tesch, 1990: 60).

However they are classified, the instruments employed in these studies do not fall into the mainstream of educational research. What is more, the clinical interview does not accord with the preferred methods of psychology either. Only developmentalists accept them as "a compromise between the passive non-intervention of naturalistic observation and the systematic manipulation of independent variables and precise control that characterise laboratory methods" (Shaunessy and Zechmeister, 1997: 88).

4.5.3 Analysis of the data

Although Piaget's (1929) book is referenced by most of the educational researchers mentioned in this chapter, not one refers to his warnings (mentioned in chapter three) about the varied nature of responses made by young children. In fact, it seems that the responses of children at any age were simply taken at face value.

Another feature of the studies reviewed in this chapter is the scant reference they make to the work of developmentalists reviewed in chapter three. Although Carey's (1985) work is referenced by Leach and his colleagues several times, they do not relate their findings firmly to the core idea in her book, that children's theory of living things is restructured between the age of four and ten years. Even when they mention the need for older children to restructure their idea about air from 'air is nothing' to 'air is a substantive medium', they claim that "any comment on the nature of progression and what drives it is pure speculation," (Leach, Driver, Scott and Wood-Robinson 1995: 752). They comment that "the nature of concepts used by young children about various non-human animals seems to be ontologically different from those used by older pupils in the sense that young children often use human behaviour as a metaphor for that of animal behaviour" (Leach, Driver, Scott and Wood-Robinson, 1996b: 140) but they do not suggest theory change by way of explanation.

4.6 Conclusion

Studies of children's response to questioning about biological topics provide insight into the way knowledge and understanding develop over time. These studies also provide discussion of some explanations offered by educationists for age-related changes.

In particular, some key areas of knowledge and understanding relating to the chosen concept, the organic origin of food, feature in this review. These are human food and its transformation in the body, the needs of plants for healthy growth and something of the relationship between animals and plants. A number of persistent misconceptions, intriguing statements of younger children and inconsistent responses have been identified. However, neither the source of children's scientifically correct knowledge and understanding, of persistent misconceptions nor of their surprising or inconsistent responses in these areas has been studied in any detail. Another aspect of the topic which remains unexplored is the relationship

between the food children eat and the living processes that take place in farm animals and plants. These are the subject of the rest of the thesis.

PART TWO: THE EMPIRICAL ENQUIRY INTO THE DEVELOPMENT OF CHILDREN'S KNOWLEDGE AND UNDERSTANDING

CHAPTER FIVE

THE DEVELOPMENT OF CHILDREN'S KNOWLEDGE AND UNDERSTANDING OF THE ORGANIC ORIGIN OF FOOD: METHODOLOGY FOR THE EMPIRICAL ENQUIRY

5.1 Introduction

The aim of this chapter is to give an account of the methodology employed in seeking to answer the question: 'How do knowledge and understanding of the organic origin of food develop in children from the age of four to eight years?'

5.2 Outline

Firstly, there is an account of the research design and the participants in the study. Then the three pilot studies are described, together with relevant findings. Following from this, the research question is analysed and translated into a researchable form. The conduct of the interviews is described next. Then there is an account of the ways in which the data were analysed. Finally, conclusions are drawn.

5.3 The research design

There are two options for the design of a developmental study: it can be either longitudinal or cross-sectional. The advantage of a longitudinal design is that the same individuals are assessed at different points in time. In the case of the present study it would mean that the same children were interviewed at age four, six and eight. This would provide information about normative changes that occur in subjects over a chronological period of four years. However, a confounding factor of longitudinal designs is that the very act of assessment has an effect on the subjects taking part. In the case of the present study it would mean that if subjects were questioned about aspects of the scientific topic at the age of four and again at six, they might direct more attention to that topic between those ages than children who have not been questioned. They would therefore learn more about it than they would have done otherwise. On being questioned about the topic subsequently the

development recorded would then be greater than in children of the same age who had not been questioned previously.

A cross-sectional design, on the other hand, is one in which at least two cohorts are assessed at the same time. This means that in the present study there would be three groups of children who are interviewed at the same point in time but who differ in age. This design has the advantage that none of the subjects have been questioned on a previous occasion and so their learning has not been influenced by the interview process itself. However, it is not possible to be sure whether the apparent developmental progression between cohorts of different ages is due to age or simply the product of individual differences. Therefore, in this design it is important to match each cohort as closely as possible.

It can be seen that each of the two options described above presents both advantages and disadvantages. In the case of the present study a longitudinal design would have required a period of data collection lasting four years, whereas the time that was available for child interviews was six weeks. Therefore a cross-sectional design was employed.

5.4 Participants

All the names of locations, schools and individuals, have been changed in this account in order to preserve anonymity.

5.4.1 The Local Education Authority

Permission to carry out fieldwork in Local Authority schools was requested from the Chief Education Officer before any schools were approached. In response, a police check was performed on the researcher before permission was granted.

5.4.2 The schools

The head teachers of the schools, called for the purpose of this study, Manor House primary school and Manor House nursery, its feeder nursery school, were approached for permission to carry out the field work. A brief explanation of the project was provided in each case during a personal interview. Later, for reasons described below, the same procedure was conducted with the head teachers of Sea View primary school and Sea View nursery.

For reasons of practicality it was decided that field work should be carried out within reasonable travelling distance of the researcher's home. Preliminary inquiries were made at the University in order to identify a nursery school and its receiving primary school which were not engaged in other research projects at the time of the study. While it was impossible to choose a locality that represented in microcosm the full social range of families in the Local Authority in which the study took place, some care was taken to make sure that the catchment area included children from a variety of homes so that findings from the study might be credibly generalised to similar settings in the UK. The schools were located on the perimeter of a large, modern private housing estate. They served part of this estate and also older, more modest housing, some of which was owned by the local council. It was expected, therefore, that the pupils would represent a good social mix. However, once the study was under way it transpired that the proportion of pupils from homes of low socio-economic status was under-represented compared with the Local education Authority as a whole.

Although Manor House primary school had more pupils in each age group than were required for the study, a further complication became apparent part-way through the data collection phase. The number of children actually available for interview at Manor House primary school who met the decided age criteria at the time of the study was insufficient. It was therefore necessary at that stage to involve another nursery and its receiving primary school in the project. The additional schools were approached through a teacher at Sea View Primary School who was already known to the researcher and was able to help at short notice. It was situated in a 'pit' village (built to house miners who worked at a coal mine which had closed a few years previously), thus serving a population experiencing high unemployment and at social disadvantage. The pupils at this second school and its feeder nursery thus provided a balance to those at Manor House with regard to social composition. The very few children of ethnic minority families (one or two in each year group), who attended the Manor House schools were not included in the study because their use of English was not sufficiently fluent for them to understand and respond to the interview questions. No individuals of ethnic minority origin were seen in Sea View village.

During the time between the pilot and main studies, Manor House nursery school was closed and its facility incorporated into a spare classroom at Manor House primary school, whereupon it became a nursery class under the direction of the same head teacher as the primary school.

5.4.3 The teachers

Shortly before each block of interviews was to take place, individual class teachers were approached. The purpose of the research was explained briefly and permission requested verbally to work with that class.

5.4.4 The parents

A letter to parents was sent home with each child explaining the project (Appendix I). Each letter included a returnable portion which when signed gave written permission for the child to take part in the interviews.

5.4.5 The children

Each teacher introduced the researcher to her pupils and explained the project in general to the whole class. Then the researcher assisted in the classroom as a helper under the direction of the teacher in order to become a familiar and accepted person by both teacher and pupils. This took place for two half days with each class (including both morning and afternoon classes in the nursery).

Each pupil was approached individually; first by the teacher and then by the researcher, in order to request permission for an interview. The child was shown the pack of pictures and the tape recorder and asked whether he or she was willing to talk about the pictures and to speak into the tape-recorder. As an incentive, each individual was informed that there would be an opportunity to hear part of the recording at the conclusion of the interview. Two nursery pupils refused permission to be interviewed and their wishes were respected.

5.5 Revision of the interview plan

The classes were interviewed in age order, beginning with the nursery class. Therefore, thirty nursery pupils were interviewed first. The order in which children were interviewed was expected to be random. This is because children were brought to the researcher for interview by the nursery staff as they had finished one activity and before they began another. Only at the conclusion of these interviews did it become apparent that the sample of children selected for interview was not as random as the researcher intended. Instead, the staff had been biased towards those pupils they expected would have plenty to say to the researcher. As consequence the sample contained many more girls than boys. Therefore, the researcher discarded

the final three interviews with girls and returned to the nursery to interview three more boys (the only remaining boys who had returned parental permission forms).

Once the interviews with six-year-old children began a further difficulty in finding suitable subjects for interviews emerged. Although there were approximately forty pupils in the year group at Manor House school, a few of them had not yet reached their sixth birthday by June, the month in which the interviews took place. Furthermore, written parental permission was not forthcoming for several of the pupils. In all, only eighteen pupils were interviewed. Therefore the researcher undertook negotiations with Sea View primary school and its feeder nursery school to make up the numbers.

In order to maintain a good match of children, facilitating comparison from one age cohort to the next, twelve Sea View children at age four, six and eight were interviewed. A further twelve interviews recorded at Manor House nursery were therefore discarded. This was done by removing at random two of the cassette tapes on which the interviews were recorded. The interviews from Manor House that were used in the data analysis were therefore composed of eighteen children at each age of four, six and eight.

5.6 The Pilot studies

Three pilot studies were carried out in order to refine the interview procedure.

5.6.1 Pilot One

This study was undertaken with children at Manor House nursery in order to discover the feasibility of interviewing very young children in a nursery setting.

In the open-plan environment of this nursery the policy was that children could see all the activities that were made available by staff. They were free to join whatever activity they chose. It was suggested that the researcher carried out individual interviews in a small 'quiet' room used for group story-telling. Children knew that if the door to this room was open they were free to join the group but that if it was closed they were not. The difficulty for the researcher was that in a climate of concern about child abuse it was not politic for an adult to withdraw a single child for interview with the door closed. Conversely, with the door open it was not long before two or three extra children made their way into the quiet room uninvited.

When their turn came to be interviewed these children tended to repeat the responses of the child they had overheard previously.

As a result of this pilot study it was decided to negotiate with staff to carry out the interviews in a more suitable place, to work with staff to produce a list of children to be interviewed, and to request assistance in withdrawing the children to be interviewed one at a time.

The data obtained in the first pilot study were subjected to three different types of analysis in order to test their suitability for use in the main study. These were the (i) Bliss classification system, (ii) concept maps and (iii) spreadsheets.

(i) The procedure used by Bliss and her colleagues (1983) involves a nested classification system which is particularly useful where the ideas represented do not have a simple relationship to each other. When applied to the pilot data it proved unnecessarily complicated.

(ii) The use of concept maps, as described by Novak and Gowin (1984) can be used in analysis. It proved useful for the indication of relationships among items but was less clear in its representation of frequency of responses and the change in those frequencies with age.

(iii) The categories of response were entered into a spread sheet and the frequency of each category presented in the form of a table. This form of representation was seen to be particularly helpful in displaying changes in children's responses with age and was employed in the analysis of data in the main study.

5.6.2 Pilot Two

This study was carried out to test the design of a semi-structured interview formulated to discover children's knowledge of the origin of food items. It also informed the choice of a suitable age interval between cohorts as the nature of the responses could be compared with those given in the first pilot study. It was conducted with seven-year-old pupils at Sea View primary school. A single photograph of a burger meal was discussed with each child. It portrayed chipped potatoes, a split bread bun sprinkled with sesame seeds, a cooked beef burger, lettuce, sliced cucumber, tomato and mayonnaise.

As a result of this study it was decided to use a series of photographs, shown one at a time, to guide the progress of the interview and to provide structure. This was necessary to maintain the children's interest.

Having observed the difference in response to the pilot interviews between nursery and seven-year-old pupils, an interval of two years between cohorts was chosen for the main study.

5.6.3 Pilot Three

This pilot was a trial of the set of photographs to be used in the main study. Much consideration was given to the question of whether a photograph of pasta should be included. Although the decision was taken to include this photograph, on analysis of the interview transcripts it was found that the resulting data provided no useful information. Most of the children could identify the pasta, but none had any idea what it was made from. Details of this part of the interview are therefore omitted from the report of the findings in chapter six.

5.7 The research instrument

5.7.1 Rationale

The research question has been stated as: 'How does knowledge and understanding of the organic origin of food develop in children from the age of four to eight years?' The semi-structured interview was designed in order to obtain an answer to this question. The strengths, limitations and possible interpretations of semi-structured interviews is discussed in chapter four.

The research question was separated into three parts:

- a) How does the stated knowledge of the origin of individual food items develop in children aged four to eight years?
- b) Are the children able to demonstrate understanding that people depend upon plants, either directly or indirectly, for all their food?
- c) What is the relationship between children's stated factual knowledge of the origin of individual food items and their demonstrated understanding of our dependence upon plants?

The rationale for devising an instrument for each of these is described below.

a) The development of factual knowledge

The administration of a test with pre-determined correct and incorrect responses might be considered the most appropriate instrument for determining *correct factual knowledge* in children. However, it is explained in the introduction to this thesis that

the purpose of this study is exploratory rather than to test an hypothesis. Therefore, whereas a test presents the subject with a set of closed questions, there is a need in the case of this study to make the questioning as open-ended as possible so that there is the opportunity for each child to respond in a different way and to value all the responses. Therefore a semi-structured interview of the type employed by educational researchers (whose work is reviewed in chapter four) was considered an appropriate option. The visual stimuli for this part of the interview consisted of eleven colour photographs showing food-related items.

b) The development of understanding of human dependence upon plants

The use of semi-structured interviews for determining children's *understanding* is well-documented in chapter three. The visual stimulus for this component was the final colour photograph of a food-related item presented in the semi-structured interview.

c) The relationship between factual knowledge and understanding

According to the authors whose work is reviewed in chapters three and four, the relationship between factual knowledge and understanding is not straightforward. Understanding arising from an increase in factual knowledge involves the organisation of knowledge into coherent structures so that meaningful relationships can be seen among the different components. Therefore, it was decided to test for a statistical relationship between the findings for knowledge and for understanding. The way in which this was done is explained later in the chapter.

5.7.2 Scientific background

The essential attribute of food is that it provides an organism with the energy needed to maintain life.

Green plants are autotrophs, that is they make all their own food from the basic ingredients of water, carbon dioxide and minerals with the aid of energy from the sun. The fundamental process of this food production in plants is photosynthesis. It takes place in chloroplasts (minute organelles possessing the pigment chlorophyll), which furnish a green colour to the cells containing them. They utilize light energy from the sun, water from the soil, and carbon dioxide from the air to produce glucose, a simple sugar. Molecules of glucose and other simple sugars are joined together to form more complex sugars and into the long, branched chain molecules of starch. This is the form in which carbohydrates are stored, for example in over-

wintering roots and tubers. Another complex molecule built from simple sugars is cellulose, the substance of plant cell walls. These carbohydrates can be converted into oils and fats, which have an even higher energy content per unit weight and thus are particularly useful for storage in seeds. With the addition of nitrates and minute quantities of other minerals obtained from the soil, sugars can be used in the construction of the twenty-two amino acids which are needed to produce proteins, the essential ingredients of the living component of each cell.

Animals cannot carry out photosynthesis and so they rely upon plants either directly or indirectly for their food. Herbivores such as cows and sheep eat plants and so their nutritional dependence upon them is obvious. Their digestive systems are specialized in order to extract nutrients from cellulose. Carnivores such as dogs and cats eat meat obtained from the flesh of herbivores and therefore their dependence upon plants is not immediately apparent. Pigs and chickens are omnivores: they normally consume a mixture of food derived from both plants and animals but cannot digest cellulose.

Human teeth and digestive system are adapted for a diet including both plant and animal material. All human food, either from plants or from animals, has an organic origin. However, the organic origin of common food items is not necessarily obvious to young children. Human food as experienced by children in the UK is in the main obtained in a prepared and packaged state from supermarkets. For example, fruit and vegetables are picked and trimmed, eggs are collected from nests and packaged in cartons, milk is drawn from cows and sold in bottles, meat is removed from the carcass and presented in convenient slices. Furthermore, many purchased items are not these basic, uncooked items but are processed in various ways before purchase. Thus milk is converted into cheese, grain into breakfast flakes and bread, and potatoes into pre-cooked chips.

Even when children are in possession of these facts they still may not realize that all their food originates from either plants or animals. Furthermore, they may not understand that all animals depend either directly or indirectly upon plants for their food.

The first research question can thus be refined as follows:

- a) Are young children able to demonstrate factual knowledge of the organic origin of some well-known examples of raw and processed foods?
- b) Can they state that the animals which provide food items depend upon plants for their own food?

The second research question can be operationalised as:
Do children understand that if all the plants in the world were to die then animals, including humans, would soon be without food and would die too?

5.7.3 Construction of the research instrument

It was decided that thirty children should be interviewed at each of three ages: four (Nursery pupils), six (Year One pupils) and eight (Year Three pupils) as shown in table 5.1.

Table 5.1 Children who took part in the interviews.

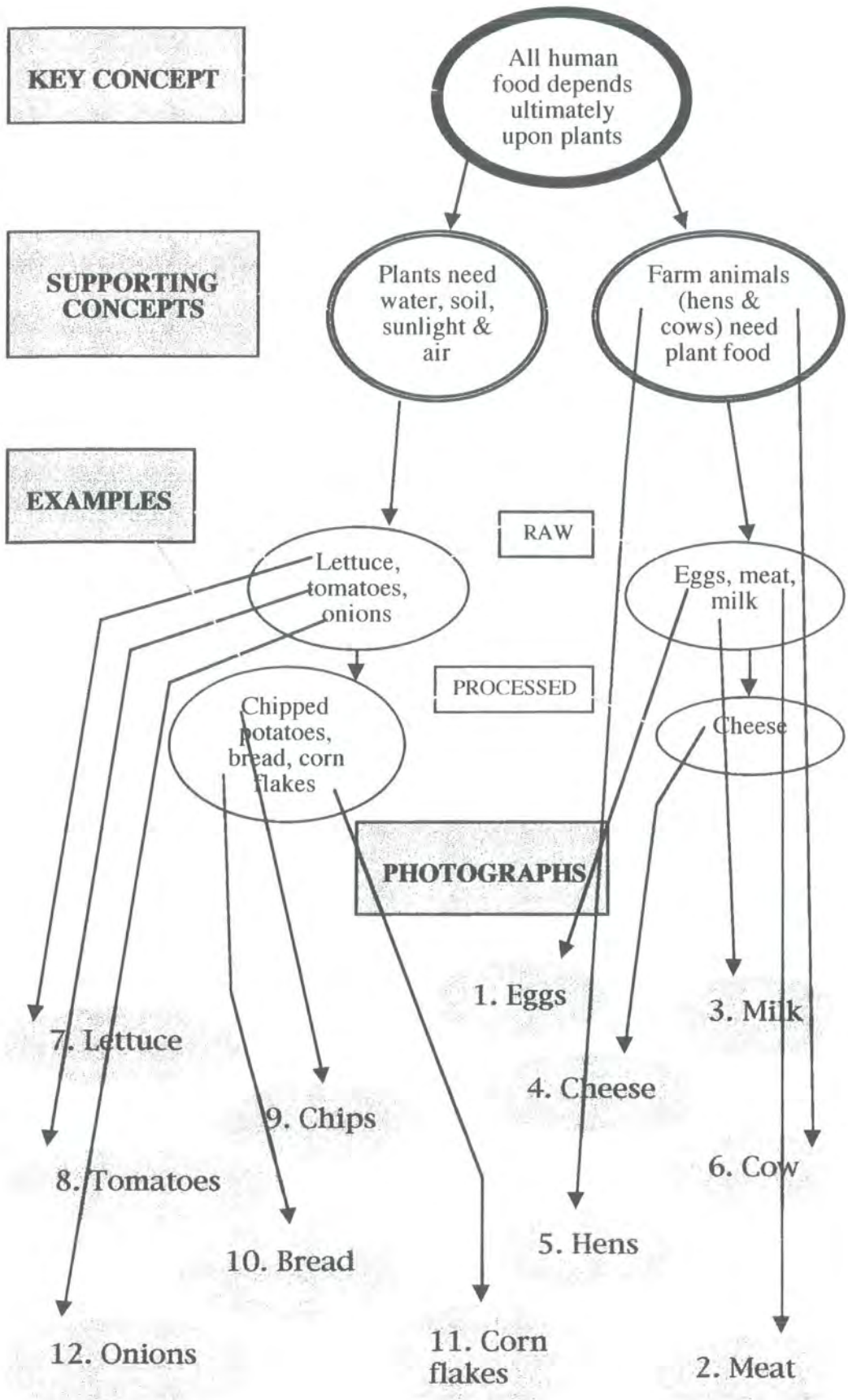
Year group	Age (in years)	Number of children
Nursery	4	30
Year One	6	30
Year Three	8	30

A two-year age gap was considered appropriate since a one-year gap would not show sufficient difference in the findings and a larger age gap would take the study outside the age range of interest. The total number of children to be interviewed would therefore total ninety in all. This was considered to be the maximum number the researcher could interview in the time available. In reality, due to the problems that are described above, one-hundred-and-five children were interviewed and fifteen interviews with four-year-old children discarded.

A condition for the choice of instrument was that it must be suitable for all the children involved, from age four to eight, and for children of all the social backgrounds represented in the study. Therefore photographs of familiar food items, sold in local supermarkets, were chosen.

The choice of food-related items depicted in the photographs was made with the help of a concept map, a planning tool first described by Novak and Gowin (1984). Originally intended as an aid to teaching and learning, “concept maps work to make clear to both students and teachers the small number of key ideas they must focus on for any specific ... task.” (Novak and Gowin 1984:15). These authors explain that “concept maps should be hierarchical; that is, the more general, more inclusive concepts should be at the top of the map, with progressively more specific, less inclusive concepts arranged below them” (Novak and Gowin, 1984:15).

Figure 5.1 Concept map for instrument development



The concept map constructed in the planning of the semi-structured interviews is shown in figure 5.1.

Twelve A4 colour photographs, of the items numbered on the concept map, were mounted on card. The possibility of using actual items in place of some of the pictures was considered but rejected on the grounds that the children might have wanted to eat some of the items, eggs might break and vegetables decay. Also, it would not have been possible to present the food items themselves in the same orderly manner, one at a time, as was possible with photographs. Each photograph was selected from teaching materials found in the schools or from supermarket wrappers, so providing ecological validity.

5.7.4 The interview schedule

As the interviews were only semi-structured, the procedure was not identical in every case. However, the photographs were always shown in the same order. The schedule described below provides the basic plan for the interviews. An example of a typescript of one interview at each age (four, six and eight) is to be found in Appendix II. The basic plan on showing each photograph was first to provide a conversational exchange which would both help the child to feel at ease and to focus upon the photograph. This was the orientation sequence. Then, for photographs of the food items, the child was asked the origin of the food. For photographs of the two farm animals the child was asked what the animal would eat. The source of the child's factual knowledge is the subject of part three of this thesis. Information which contributed to that part of the study was elicited through a further question put in the semi-structured interviews: "How do you know that?" Supplementary questions were asked when appropriate, so that if a child had seen chickens on a farm he or she was asked who had taken them on the visit. The final photograph, of a food item growing in a garden, was used to ask children what plants need for growth (although in some cases this question was asked in connection with other photographs if it seemed appropriate).

The final photograph was also used as a stimulus for probing the child's understanding of human nutritional dependence upon plants by asking what we would do for food if all the plants died. Since all the questions in fact lead up to this final one, it might be assumed that the very questioning procedure would act as a teaching tool to help the child think of the correct answer. However, as is evidenced in the results provided in the next chapter, this was not the case. In fact the question

was not presented to the four-year-olds as it was considered too difficult for them. In the event, it proved to be very challenging for the six-year-old children.

The wording of the questions was designed to match that normally used by teachers of young children when talking with their pupils. Notwithstanding this, in accordance with Piaget's (1929) advice for this type of interview (noted in chapter three), the researcher attempted to convey no value judgements in relation to the responses made by the children. Instead, they were reassured and encouraged by positive utterances such as the frequent use of the word, "right". The tone of voice used in the utterance of this word was not sufficiently emphatic to indicate that the response was factually correct. Nevertheless, it was intended to convey that the response was accepted. Responses were also frequently repeated back to the children, firstly in order to reassure them that they were accepted but also to make transcription easier, as the child's voice was not always distinct on the tape-recording.

A typical schedule is described on the page preceding each photograph:

1. Eggs

Orientation

There are some eggs, frying in the pan. Do you like eggs?

Do you like them fried like that?

How else do you like them cooked?

Do you ever help in the kitchen?

What do you do?

You can see the egg shells there. There are some eggs still in the box.

Research question - knowledge

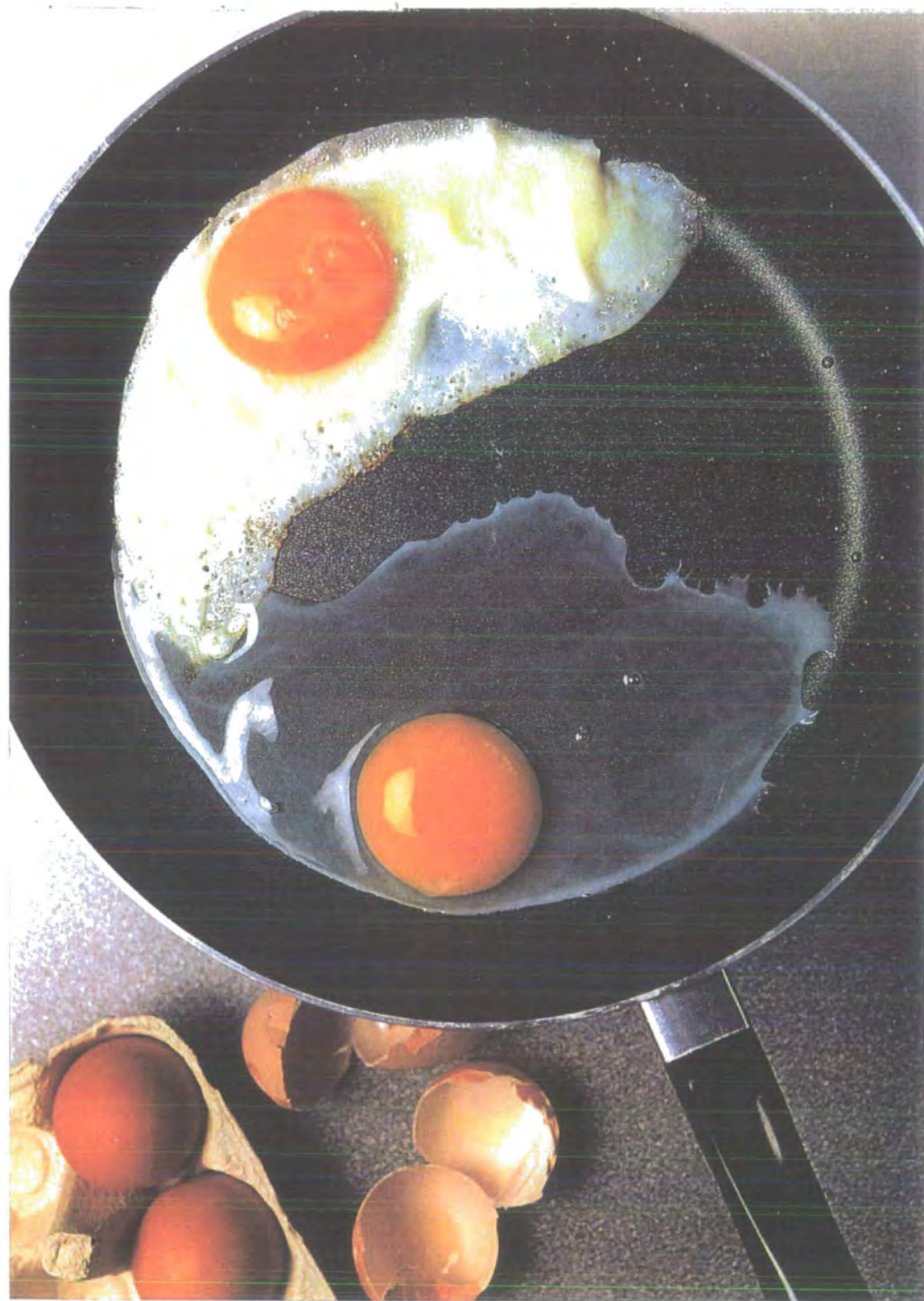
Can you tell me where eggs come from?

(repeat the child's response).

If the child says, "The shops," he or she is then asked, "Where do the shops get them from?"

Research question - source of knowledge

How did you know that?



2. Meat

Orientation -identification

What's that?

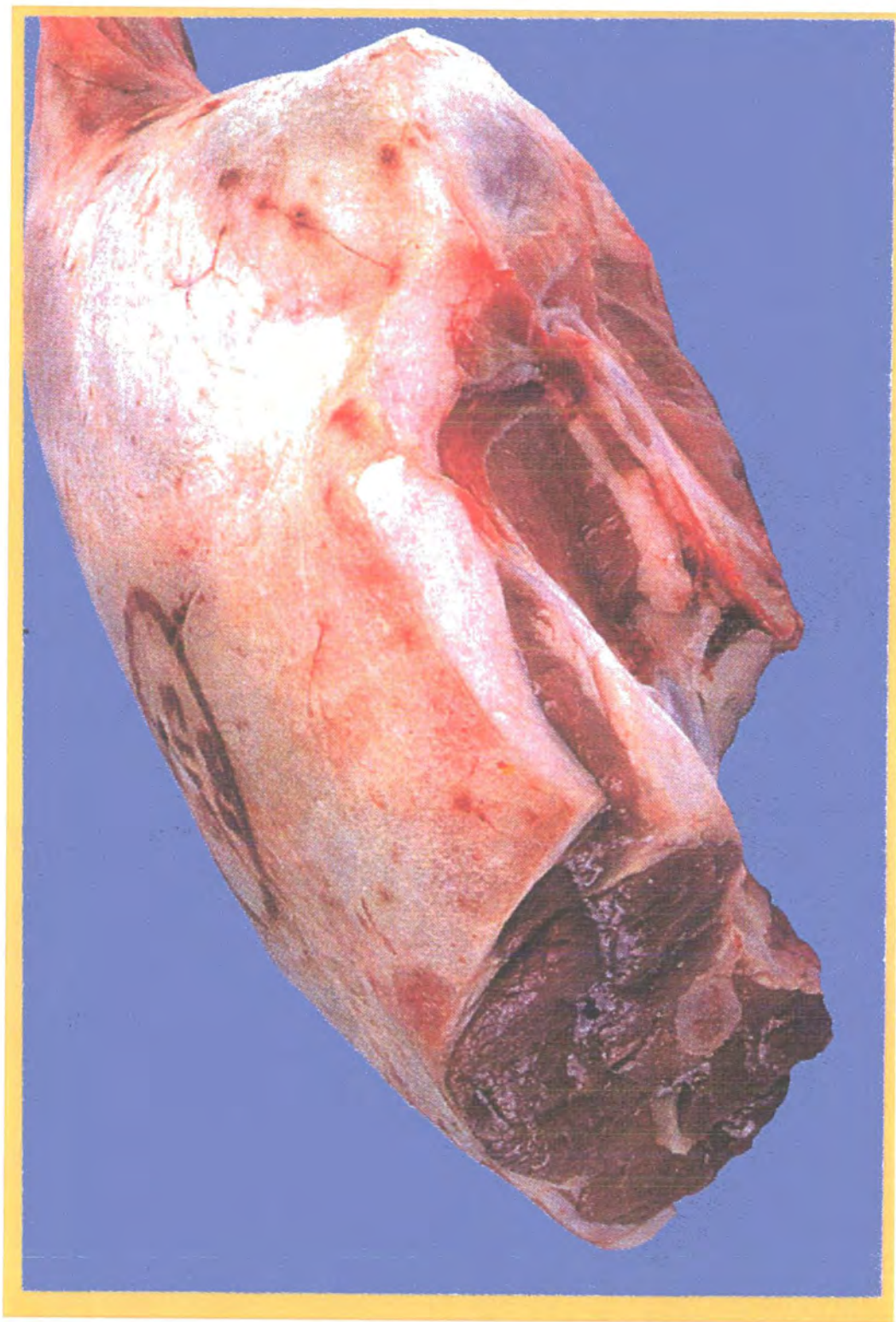
(repeat child's response/clarify)

Do you like to eat (child's response, e.g. 'chicken') when it's cooked?

Research question - knowledge

Do you know where we get (X) from?

Do you know the name of any other sort of meat?



3. Milk

Orientation

(Pointing to different items in the picture)

That's the sort of milk the milkman leaves on the step, and those are the sorts you get from the supermarket.

Do you like to drink milk?

Research question - knowledge

Can you tell me where milk comes from?

Research question - source of knowledge

Cows, right. How do you know that?

(if child has seen it on TV) Is it a video that you've got, or is it a programme?

Do you know what it (the video/programme) was called?



4. Cheese

Orientation

What's that?

Do you like cheese?

What sort do you like?

Research question - knowledge

Do you know how to make cheese?

(if child doesn't know) Can you guess what goes in to make cheese?

Research question - source of knowledge

(when a response is forthcoming) How do you know that?



5. Hens

Orientation - about the child

Here are some chickens/hens.

(with the four-year-old children) What noise do the hens make?

Research question - source of knowledge

Have you seen any hens/chickens in real life?

Where was that?

Did you go with the school or did you go with your family?

Research question - knowledge

If those chickens/hens were hungry, what would you give them to eat?

What sort of food would they like?

Can you guess?

What would you try them with?

Is there anything else they might like?

Research question - source of knowledge

Have you seen them eating (the food mentioned, e.g. corn)?

Have you seen a real life farmer giving them (e.g. corn)?

Research question - testing knowledge claim

Can you tell me what corn looks like?

Research question - knowledge

(If the child did not state that eggs come from hens in response to the first picture) What do the hens give the farmer/Why does the farmer keep the hens?



6. Cow

Orientation

Here is a cow.

(with four-year-old children) What noise does the cow make?

Have you seen any cows in real life?

Research question - source of knowledge

Where were they?

Research question - knowledge

Can you show me which part of the cow makes the milk?

Information (correct terms) given

That's called the udder, that makes the milk.

Those are the teats that you squeeze to get the milk out.

Research question - source of knowledge

Have you seen a cow being milked?

Was it on the TV or in real life?

(if TV) Was it a video or a programme? What was it called?

Research question - knowledge

If the cow was hungry, what would it eat?

Do you think it would eat anything else?



7. Lettuce

Orientation

What's that? (researcher clarifies identification if child is not sure).

Do you eat lettuce?

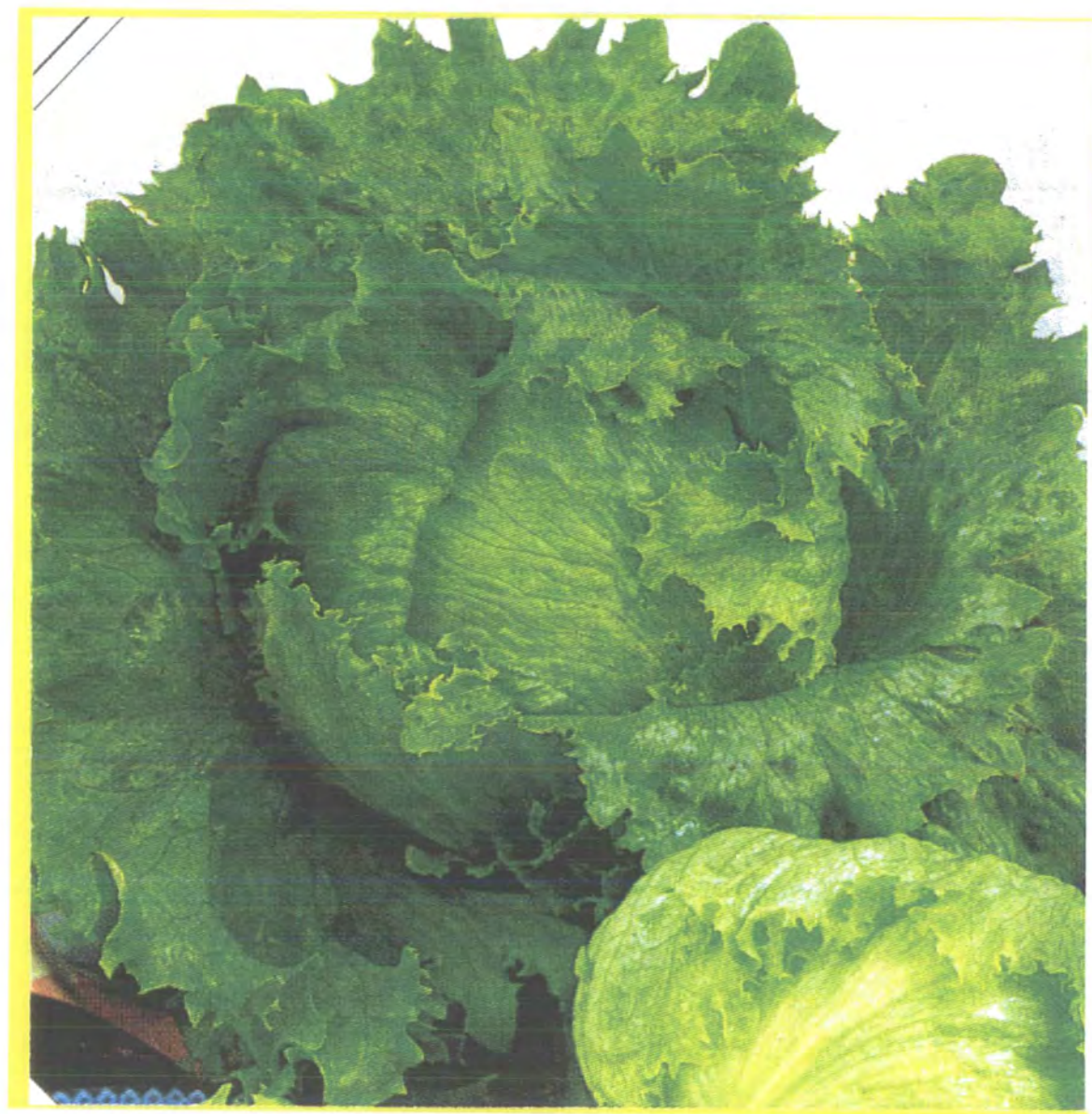
Research question - knowledge

Can you tell me where lettuce comes from?

Research question - source of knowledge

(when a response is forthcoming) How do you know that?

Who do you know that grows lettuces?



8. Tomatoes

Orientation

What's that?

Do you like to eat tomatoes?

Research question - knowledge

Where do tomatoes come from?

(if the response is "the shops") Where do the shops get them from?

If you cut open a tomato, what can you see inside?

Research question - source of knowledge

(when a response indicating seeds is forthcoming) Have you ever planted little seeds of anything?

(if the response is in the affirmative) What have you planted?

Research question - knowledge

What did you have to do to help it to grow?

Did it need anything else to help it to grow?



9. Chipped potatoes

Orientation

Do you like chips?

Who cooks the chips in your house?

Research question - knowledge

How does s/he do it?

(if potatoes are not mentioned in response to the previous question) They are made from potatoes.

Do you know where potatoes come from?

Research question - source of knowledge

(when a response is forthcoming) Have you seen them growing?

Research question - knowledge

Where about on the plant do the potatoes grow?



NO ARTIFICIAL COLOURS
FLAVOURS OR PRESERVATIVES

SEE SIDE
FOR BEST BEF

10. Bread

Orientation

Here is some bread.

Do you like white bread or brown bread?

What do you put on your bread?

Do you make sandwiches?

What do you like to put in your sandwiches?

Research question - knowledge

Do you know how to make bread?

Do you know what goes in to make it?

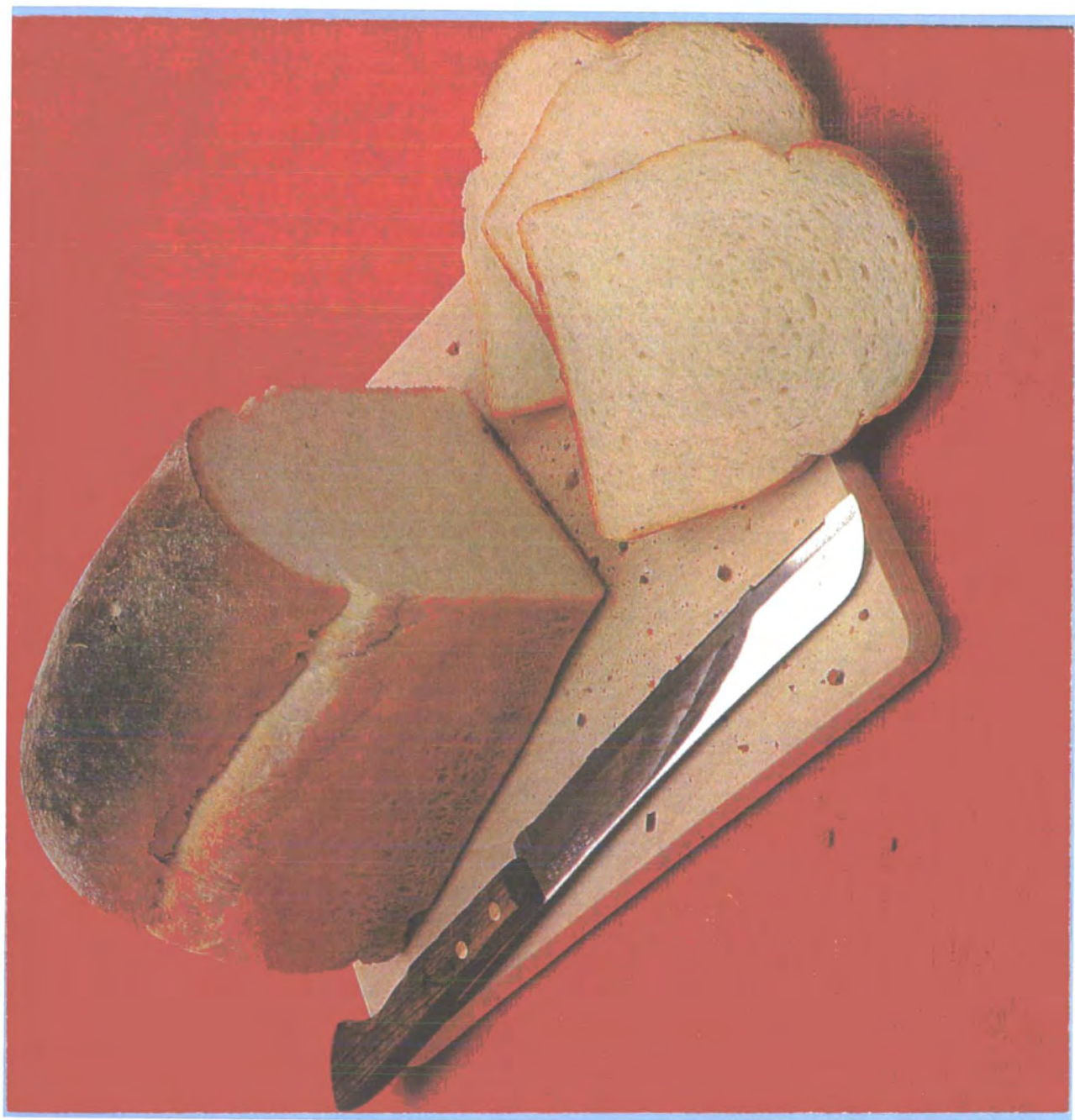
Research question - source of knowledge

Have you seen/helped to bake bread?

Prompt question

Have you seen/helped to bake cakes?

What goes in to make them?



11. Corn flakes

Orientation

What's that?

(for those who are not sure) They are corn flakes in a bowl. You can see the milk?

Do you like corn flakes?

Did you have them for breakfast this morning? What did you put on them?

Research question - knowledge

Do you know what corn flakes are made from?

Research question - source of knowledge

How did you know that?

Did you guess?



12. Onions

Orientation

Do you know what that is?

It's onions, growing in someone's garden.

Research question - source of knowledge

Have you seen anything you can eat, growing?

(if yes,) Who grows vegetables?

Have you helped to grow/picked anything you can eat?

Research question - understanding

If the rain didn't come/there was no sunshine, and all the plants died, what would we do for food?

(if the child says, "I would eat X (e.g. tinned food") If there wasn't any X, what would you do?

(if the child says, "Meat") But we get meat from a cow, and what does the cow eat?

(if the child says, "I would get some from the shops,") But what would you do when the shops had none left?



5.8 Conduct of the interviews

The timing, conduct and children's response to the process are described in this section.

5.8.1 Timing of the interviews

The time of year chosen for data gathering was decided in view of the researcher's knowledge of very young children. They need to become at ease in the school environment before being questioned by an unfamiliar adult. As the nursery children were admitted either in September or January, the summer term was chosen as the optimal time of year. However, observations during the pilot studies indicated that in the month of July some children were absent from school as they were taken on holiday by their parents. Another unsettling factor for nursery pupils in the month of July was that they visited their local primary school in preparation for transfer the following September. Therefore, it was planned to interview the nursery pupils in May and the primary school pupils in June. Using the experience of the pilot studies, the estimated time necessary for the child interviews was six weeks. In order to allow for unforeseen difficulties, the total time planned for data gathering was eight weeks. This time was negotiated with the researchers' employer twelve months in advance. In the event, due to the unexpected need to work in Sea View Nursery and Primary schools as well as in Manor House schools, the full period of eight weeks was utilized.

5.8.2. Organization of the interviews

Whereas the nursery pupils at both Manor House and Sea View were interviewed in a medical room that was already familiar to them, older children were interviewed either in or near their own classroom in as quiet a corner as could be found. A portable, battery-operated cassette tape recorder was used for reasons of convenience and safety.

5.9 Data analysis

Typescripts were made of the tape-recorded interviews in preparation for analysis. A sample, selected at random, of one interview at each age of four, six and eight, is to be found in Appendix II. These typescripts were analysed both for content and as discourse, as described below.

5.9.1 Content analysis.

It was mentioned in chapter four that language as communication can be analysed for content and is therefore classified as “content analysis”, according to Tesch (1990: 60). In common with the studies described in that chapter, the typescripts in the present study were analysed for content. This related to children’s knowledge about the origin of the food items and food producers portrayed in the photographs. In the case of the six- and eight-year-old children, the typescripts were also analysed for content relating to their understanding about our ultimate dependence upon plants for food, as evidenced by their response to the final photograph.

The content approach to analysis “clearly represents an attempt to apply conventional, and indeed positivist, notions of rigour to the unruly and ostensibly subjective field of cultural meaning”, according to Slater (1998: 234-235). He explains that the central aim of this form of analysis is “to render issues of interpretation as controllable and non-contentious as possible” (Slater 1998: 235).

The typescripts of the interviews were subjected to three stages of content analysis. First, children’s knowledge statements were categorised and entered into spread sheets. Then the categoric information was tabulated and charts were produced. Finally, the categorised responses were analysed statistically.

i) The Spread sheets

An initial exploration of the content of the three transcripts found in Appendix II was made by allocating a page for each child. Responses relevant to the origin of the food were recorded under the title of each photograph. From this preparatory exploration it emerged that category headings could be made in relation to the photographs (for example, the ‘Origin of Eggs’ and ‘Food for Cows’), and that for each heading there was a small number of different responses. This process of categorisation is similar to that described by Osborne and his associates (1992: 52), who employed “firstly a simple categorisation of the answers and a frequency count”.

It was decided that information in this form was best recorded in a spread sheet. One spread sheet was allocated for each of the three age groups (at four, six and eight years of age). The three year-group spread sheets are to found in Appendix III.

The choice of category is critical, according to Slater (1998: 236), as “much of the apparent rigour of content analysis rests on the structure of categories used”. In Osborne and colleagues’ study, “some ... categorisations were based on the

researcher's understanding of commonly accepted understandings [whereas] other categorisations were based on an empirical approach to the data from the responses provided by the children". A similar approach was employed in the present study. Some categorisations were based upon commonly accepted adult understandings about the origin of food. Other categorisations emerged from the data. For example, the statement "*from shops*", indicating a commercial origin of food items, would not be expected as a response from adults but was put forward by many of the younger children.

Each child was allocated a row on the spread sheet. Response category headings, such as 'Origin of Eggs' and 'Ingredients for Bread' were allocated for the columns. The responses of each individual child were then entered into the cells. Correct responses indicating the organic origin of a food item, such as "*cow*" under the heading 'Origin of Milk' were simply recorded as "*y*" (for yes) in the spread sheet. In some cases there were several similar responses which were then grouped together. An example of this is the group of responses indicating a commercial origin of eggs. Thus, the commercial statements "*from the shops*", "*from Sainsbury's*" (a local supermarket) and "*the milkman brings them*" were all grouped together as 'shops'. In other cases, even though the responses were all correct they were listed individually. This was done in the 'Food for Hens' column, where the correct items "*leaves*", "*worms*", "*bread*", etc. because they were sufficiently different to be of interest individually. Similarly, in the column under the heading, 'Ingredients for Bread', beside the name of a single child there might be a list of words such as "*water, flour, sugar*", recording three correct items that the child named as being used in the baking of bread.

When a child indicated that the answer to the question was not known, the response was recorded as "*n*". On many occasions, especially with the younger children and for reasons explained earlier in this chapter, it was not possible to ask a child all the intended questions outlined in the interview schedule. In this case "*o*" was recorded in the spread sheet.

The categories accounted for all the relevant content of the children's responses, so fulfilling Slater's (1998: 236) advice that "they must be exhaustive". Furthermore, each response was recorded only once, obeying Slater's (1998: 236) directive that "they must be mutually exclusive".

ii) Charts of knowledge statements

It was possible to construct a percentage chart of the findings recorded for each category by counting the number of responses of each type (e.g. “y”, “n”, “o”) from a single column of categoric data recorded in the spread sheets. These charts enable the reader to see at a glance the proportion of the different types of response at the three ages.

iii) Inferential statistics: The Chi-squared test

The differences at the three ages among the responses of children within a category could be the product of chance associations. Therefore the categorised responses were analysed statistically for age correlation. As the analysis took place upon categoric data the Chi-squared test was chosen. This test makes it possible to determine the level of confidence that can be placed in regarding the changes to be age-related.

For the purpose of the statistical tests, tables of the actual numbers of children providing each response were employed. In some instances the findings illustrated in the percentage charts were recast. There were two reasons for this. Firstly, it was to ensure that the data in the table columns were mutually exclusive. It sometimes happened that a child provided more than one answer to a question, so that two or more responses were recorded for the same child, but in different table columns. Although it was considered appropriate to present all the children's answers in the percentage charts, it was not correct for the purpose of statistical analysis. For example, when children were asked to identify the items needed for plant growth, many identified several correct items, but there were only very small numbers who mentioned fertilizer, light, air and warmth (but no child mentioned all four), whereas the majority mentioned water and many also mentioned the sun. It was decided to apply the Chi-squared test only to those children who had mentioned water and to test whether there was an age-related change in the number who also mentioned the sun. These tables are provided in the text. The second reason is that it was inappropriate to apply the Chi-squared test where the number of cases in some of the table cells was too small: “you would not generally want to be making statements about groups of less than five or six cases” (Fitz-Gibbon and Morris, 1987: 99). Therefore in some tables the cell entries were collapsed, so that the test was carried out on correct/incorrect responses only.

It may be noted that Yates' correction was employed with only one of the tests because he argues that “it is with the question of the applicability of Chi-squared to 2 x 2 contingency tables involving small expectancies that we are directly

concerned” (Yates, 1934: 217). In fact, all but one of the tests described in this chapter involve more than one degree of freedom, and “in the case of contingency tables involving more than one degree of freedom, reasons are given for believing that the ordinary Chi-squared test is considerably more reliable” (Yates, 1934: 218). In any event some authors, for example, Camilli and Hopkins (1978: 242), argue against the use of Yates’ correction because “it causes the already conservative probabilities for alpha to be even more conservative”. Therefore, when applying the Chi-squared test to children’s ideas about the effect of plant death (the only 2 x 2 contingency table), results of both forms of the test are provided.

iv) Inferential statistics: The t-test and ANOVA test

Although a single correct response was not predetermined for each question, it was possible to assign a numerical score for correct factual responses given during the semi-structured interview. Each child was scored for their correct responses given to factual questions about the origin of human and plant food. Only one point was allowed per child for each of thirteen items. For example, if a child was able to indicate that lettuce is grown a score of 1 was given but if he or she gave an inappropriate response a score of 0 was allocated.

The items which were scored in this way are:

- Lettuce is a plant that is grown,
- Tomatoes are grown on plants,
- Eggs are laid by hens (in response the picture of eggs),
- Meat comes from a named animal,
- Milk is produced in the udder of a cow,
- Chips are made from potatoes,
- Bread is made from flour or wheat,
- Corn flakes are made from corn or wheat,
- Cheese is made from milk,
- Plants need water,
- Plants need soil,
- Plants need sunshine,
- Plants need minerals (fertilizer).

Thus the total number of correct knowledge responses given by each child can be calculated, giving an individual total score. Spread sheets showing the individual scores for each age cohort are to be found in Appendix IV.

As the knowledge scores for individual children provide interval data it was possible to carry out three statistical tests (t-tests) upon them for the significance of differences which have been identified in the earlier studies mentioned in chapter four. These were for gender, socio-economic status (Sea View and Manor House), and understanding.

The differences in achievement among groups of pupils have been discussed in chapter four. Harlen (1993), for example, noted a large discrepancy in performance between male and female adolescent pupils in science. Therefore the first t-test was conducted on children's individual scores when grouped according to gender.

The second t-test was designed to discover whether there is a difference in children's individual scores when grouped according to socio-economic status (Sea View or Manor House). The reason for this is that a relationship between social class and levels of scholastic attainment is frequently reported. For example, Plowden (Department of Education and Science, 1967) and Solomon (1993b) both provide examples of this. In the present study, it is noted earlier in this chapter that Sea View was less favoured socio-economically than Manor House.

The third t-test was carried out to determine the statistical significance of the difference between the score for the stated factual knowledge given by those eight-year-old children who could demonstrate understanding of the concept in response to the final question and those who could not. This was conducted in order to discover whether there was a simple relationship between factual knowledge of the origin of food items and indication of understanding that we are ultimately dependent upon plants for our food.

In choosing the type of t-test to employ, "the decision about whether the design is between subjects (producing independent samples) or within subjects (producing related samples) is absolutely crucial for a correct choice of test," note Kinnear and Gray (1997: 110). All the t-tests described above were conducted in the independent version because the scores in the two samples were "not likely to be substantially correlated" (Kinnear and Gray, 1997: 108). According to Smithson (2000: 215), the independent t-test is the "between subjects t-test [which] ... is traditionally used for comparing the difference between the sample means against a null hypothesis difference (usually the 'no effects' hypothesis)".

The formulation of scores for individual children also allowed a test to determine the overall significance of age in relation to knowledge. This was done with an analysis of variance (ANOVA) test.

5.9.2 Discourse analysis.

As well as the content of exchanges, one can also examine the process of communicating itself, that is “in the forms and mechanisms of human communication and verbal interactions”, according to Tesch (1990), who notes that when text is analysed in this way it is known as discourse analysis. However, discourse analysis “can sometimes be a difficult method to pin down because it is used in different ways” (Tonkiss, 1998: 246). In this thesis, after the transcripts were analysed for content they were examined for the nature of the exchange between the researcher and individual children. “For the discourse analyst, language is both active and functional in shaping and reproducing social relations, identities and ideas” (Tonkiss, 1998: 248). The nature of these exchanges was not anticipated before the interviews began so that there was “a certain ‘wait and see’ attitude to what the data ‘throw up’” (Tonkiss, 1998: 251). In this case, “the overall discursive effect of [the] text provides a framework in which to consider its inconsistencies, internal workings and small strategies of meaning” (Tonkiss, 1998: 253). This is a sociological way of analysing talk which is also known as conversation analysis, according to Cameron (2001: 48), “where the central idea is that social actors are not just ‘dopes’ following externally imposed rules, but are always actively creating order through their own behaviour”. However, it was the breach of the normal expectations of conversational exchange which provided the starting point for the discourse analysis described in the next chapter.

5.10 Conclusion

This study is designed to “serve the important role of *probing* (in contrast to *testing*), potential causal models” (Hartmann and George 1999: 136). It is intended to “provide valuable information to developmentalists, enabling the search for an explanation - the underlying process responsible for the finding - to begin” (Hartmann and George 1999: 138).

CHAPTER SIX

EMPIRICAL FINDINGS RELATING TO CHILDREN'S KNOWLEDGE AND UNDERSTANDING OF THE ORGANIC ORIGIN OF FOOD

6.1 Introduction

The aim of this chapter is to present and discuss findings relating to the development of knowledge and understanding about the organic origin of food in children from age four to eight years. They are derived from the semi-structured interviews described in chapter five.

6.2 Outline

The findings are presented in five parts. The first part is concerned with children's factual knowledge about the origin of some familiar food items. The second is concerned with their factual knowledge of the nutrition of producers of that food. In the third part, the children's understanding of the concept, the organic origin of food is probed. The fourth part is concerned with the inferences that can be made from statistical analysis of the data and the last part is concerned with an analysis of the interview process itself.

After summarising the findings, each of a number of possible explanations for them is treated in turn. Details of the transcripts for individual children are scrutinised in order to consider how the findings can be explained. In this part of the chapter reference is made to other researchers whose work is discussed in part one of this thesis. Finally, there is an evaluation of the empirical work reported in this part of the thesis and conclusions are drawn.

6.3 Findings

As described in chapter five, transcripts of the semi-structured interviews were categorised, entered into spread sheets and the age-related differences tested for statistical significance with the Chi-squared test.

6.3.1 Children's factual knowledge about the origin of food items

In each case, the findings relating to children's knowledge are described and also summarised in a percentage chart. In addition, the table used for the calculation of the Chi-squared test is provided together with the result.

a) *Uncooked items of animal origin*

Eggs

A typical interview of a nursery pupil (age four years) is that with Carolyn (C). As in all the interviews, the researcher (R) first engaged in an orientation exchange about the child's own experience of eating and cooking eggs:

1. R. Right, here's our first picture.
2. C. It's an egg in a pan.
3. R. It's an egg in a pan. Do you like eggs?
4. C. (*Nods*).
5. R. Oh, right.
6. C. I do.
7. R. Yes. Do you help cook sometimes?
8. C. (*Nods*).
9. R. What do you help to cook?
10. C. Soup. Making soup.
11. R. Making soup. Oh, right.
12. C. And my Mummy helps. And says I can learn how to cook before, I, ... when I'm a big girl.
13. R. Oh, right. So you're going to learn more as you get bigger, aren't you?
14. C. Yes.
15. R. Mm. Right. But you help make soup now. And do you like to eat eggs?
16. C. (*Nods*). The same eggs as that one.
17. R. That one's not cooked properly, is it? (*points to the raw egg in the frying pan*).
18. C. No.

After this orientation exchange, the question relating to knowledge of the origin of eggs was posed:

19. R. Right. Do you know where we get eggs from?
20. C. From, from Sainsbury's.

Although this response is correct, it did not provide the researcher with the required information about Carolyn's knowledge about the organic origin of eggs and so the child was probed further:

21. R. From Sainsbury's. That's right. I wonder where Sainsbury's gets all the eggs from? (*pause*) I wonder where they get all the eggs from?
22. C. (*Pause*) Somewhere.

Carolyn's pause in statement 22 is evidence of her effort to bring further information to mind. However she was not successful and so could only give the

vague response, “*somewhere*” It was not considered appropriate to press this very young child further and so the next photograph was produced.

Children either said that eggs came from shops (as did Carolyn) or indicated their organic origin by giving responses such as that eggs come from hens or from a farm. With only one exception, once a child suggested that eggs came from shops it was not possible to elicit an organic origin by further questioning. Children could only say that the eggs were brought to the shops from some other place. Thus, Carolyn suggested “*somewhere*”, when asked from whence shops might get their eggs. Other children suggested that “*a man brings them*”, or they are made in “*a factory*”. For example, the six-year-old pupil, Mandy, engaged in the following exchange:

- 11. R. Can you tell me where eggs come from?
- 12. M. (*Long pause*) The shops.
- 13. R. The shops. Can you tell me where the shops get them from?
- 14. M. Some people.
- 15. R. Some people. And where do they get them from, do you think?
- 16. M. A factory.

It can be seen that even with probing she could not extend her answer.

Two four-year-old children suggested cows as the source of eggs. When Catherine stated that eggs came from a farm she was then asked for further information:

- 17. R. Does the farmer make the eggs? What is it at the farm that makes the eggs?
- 18. C. Cows.

Sarah was able to explain her reasoning for a similar response:

- 25. R. Cows, right. What makes you say that?
- 26. S. Because, because you get milk from cows and milk is like eggs.

Yet later in the interview, when shown the photograph of hens, Sarah was able to say that hens lay eggs:

- 87. R. Why does the farmer keep the hens? What does he want from the hens?
- 89. S. Eggs.
- 89. R. Eggs. That's right. How did you know about the eggs?
- 90. S. Because they lay eggs.

Thus in the spread sheet for nursery pupils the column titled “Origin of Eggs” contains two types of correct response. The first type indicates a commercial origin for eggs which includes both the general term, “*shop*” and the specific name of a supermarket, e.g. “*Sainsbury's*”. Both the general and the specific indications of commercial origin were collapsed into the category ‘*shop*’. The other type of correct

response indicates the organic origin of eggs. The words, "*hens*", "*chickens*" "*ducks*" and "*birds*" are all clear examples of this correct response. The assignment of another type of correct response, "*farms*", is not so clear. A decision was made to regard this response as an organic rather than a commercial type of response. A third type of response recorded in the "Origin of Eggs" column is that of inappropriate responses. These were only given by four-year-old children and were "*cows*", "*frozen*", and "*cluck, cluck*". In all, then, three types of response were recorded at the second level of analysis. A few children gave both an appropriate and an inappropriate type of response. In this case the appropriate response was the one recorded for the second stage of analysis.

Some of the eight-year-old children were able to incorporate knowledge acquired from recent science lessons into their interviews. For example, eight-year-old Stephanie offered information about the nutritional value of eggs during the orientation phase of the questioning:

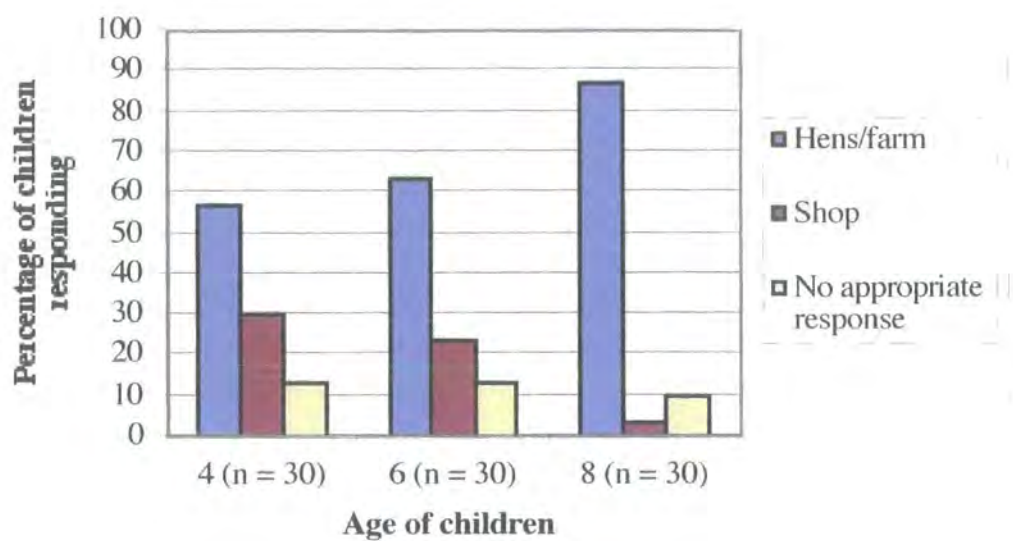
1. R. Here's the first picture. What can you tell me about that?
2. S. Erm, they're eggs.
3. R. Right.
4. S. And they're protein.
5. R. Right. So that's a source of protein in your diet, isn't it?
6. S. Yes.

Stephanie's class at Manor House school had recently experienced lessons about this. No such information was offered by pupils at Sea View school as they had not yet been taught about the components of a healthy diet. Even though Stephanie was confident to offer information about the protein content of eggs, she required prompting before she could describe the organic origin of eggs:

33. R. OK. Right. Erm, now what can you tell me about where eggs come from?
34. S. (*Long pause*).
35. R. Where do eggs come from?
36. S. (*Long pause*). A farmyard.
37. R. Right. Whereabouts in the farmyard?
38. S. Hens.
39. R. Right. I thought you'd know that really.

Stephanie's responses show that she rightly understood the questioner's requirement for information about the organic origin of eggs rather than about where they might be purchased. There was a clear age difference in the frequency of these two types of correct response, as shown in the percentage chart, figure 6.1.

Figure 6.1 Statements about the origin of eggs shown in the photograph



Overall, younger children more frequently stated that eggs come from shops than did older children, whereas the responses of older children more frequently indicated their organic origin.

Table 6.1 shows the way the responses were cast for the purpose of the Chi-squared test.

Table 6.1 Statements about the origin of the eggs shown in the photograph

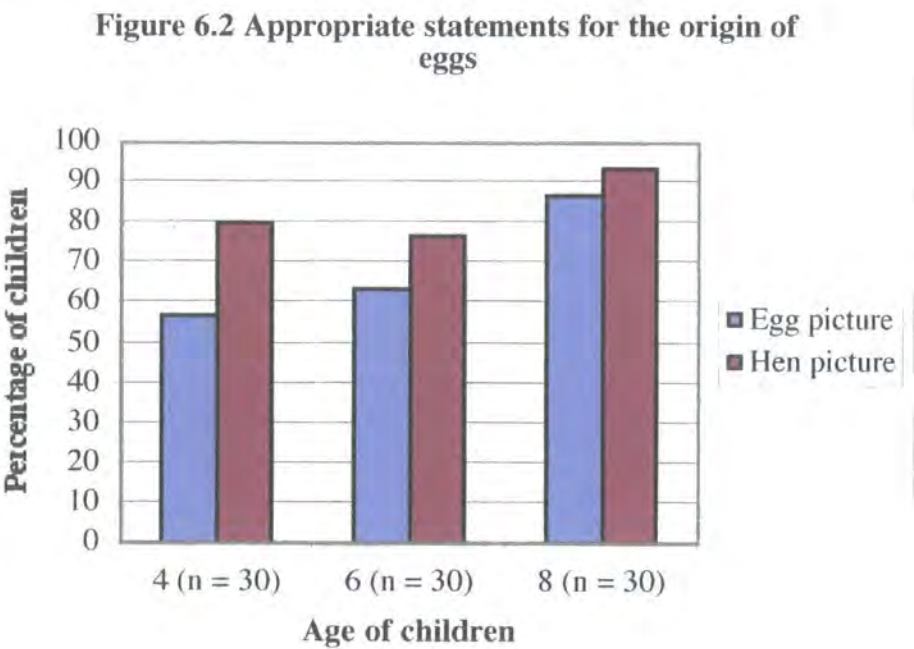
Age in years	Hens/farm	Shop	No appropriate response
4 (n = 30)	17	9	4
6 (n = 30)	19	7	4
8 (n = 30)	26	1	3

The test yields a value of 8.85, which at 4 degrees of freedom shows that the age difference is significant, but only at the 0.1 level ($\chi^2 = 8.85$, $df = 4$, $p < .1$).

An unexpected finding was that children's responses to the picture of eggs did not indicate the limit of their knowledge, as further extracts from Mandy's interview illustrate. At a later stage in the interview, when talking about the picture of hens, Mandy was able to say that hens lay eggs, although she could not explain why she had not mentioned this before:

- 75. R. So you'd find some chickens on a farm. Why does the farmer keep the chickens?
- 76. M. 'Cos they lay eggs.
- 77. R. Because they lay eggs. So when we talked about these eggs at the beginning (*pulls out earlier picture*), and I asked you where they came from, you didn't tell me it was the chickens that laid them, did you?
- 78. M. (*Shakes head*).

Almost all the children, when shown the picture of hens, stated that they lay eggs. The percentage of children's responses to the two pictures can be compared in figure 6.2.



Only a few of the younger children did not appear to know that the hens shown in the picture lay eggs even when asked why the farmer keeps them. This exchange illustrates a typical response from a four-year-old:

- 95. R. So why does the farmer keep the chickens?
- 96. C. Because he likes them very much.

Even at age six, a few children could not give an appropriate reason why a farmer keeps chickens. For example, Elizabeth, who in response to the picture of eggs had stated that they originated from shops, could not supply any further information in response to the picture of hens:

117. R. Why does the farmer keep the hens?
 118. E. 'Cos they're nice. They move their wings.

Meat

Most children, when shown the picture of an uncooked leg of lamb, were able to indicate that the picture was of meat of some kind. They either identified it as "meat", or named a type of meat, such as chicken, bacon, beef or pork. Thus, the four-year-old pupil, Carolyn, engaged in the following exchange:

23. R. Let's have a look at the next picture. What's that?
 24. C. Chicken legs.
 25. R. A chicken leg. OK.

Carolyn then told the researcher about her sister, who enjoyed eating chicken legs, before the planned questioning was resumed. Just as children suggested for eggs, Carolyn can only state the name of a supermarket when asked the origin of meat:

33. R. Oh, right. And where do we get chicken legs from?
 34. C. Sainsbury's.
 35. R. Right. Do you know where Sainsbury's gets the chicken legs from?
 36. C. No.

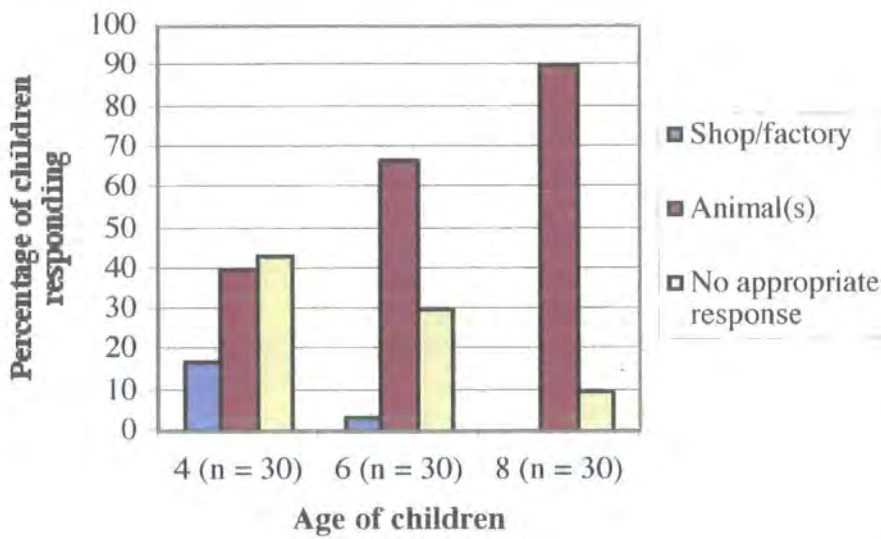
However, fifty-nine children could mention the name of at least one farm animal which is normally eaten as meat. These findings are shown in figure 6.3.

Table 6.2 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 17.43, which at 4 degrees of freedom shows that the age difference is significant at the 0.01 level ($\chi^2 = 17.43$, $df = 4$, $p < .01$).

Table 6.2. Statements about the origin of meat

Age in years	Shop/factory	Animal(s)	No suitable response
4 (n = 30)	5	12	13
6 (n = 30)	1	20	9
8 (n = 30)	0	27	3

Figure 6.3 Statements about the origin of meat



Milk

Almost all the children, when shown the picture of milk in bottles, said that milk comes from cows. Only ten children suggested that it came from a shop or a factory. Furthermore, when shown the picture of a cow, each child was asked to point to 'the part of the cow that makes the milk' (the udder). Most children at all ages could do this correctly. For example, four-year-old Carolyn, on being shown the picture of the cow, needed no prompting to show her knowledge of the source of milk, although the researcher supplied the names of the parts she identified:

90. C. That's where you get milk from (*points to udder in the picture*).

91. R. That's where you get the milk from. That's right. This part's called the udder. Those are the teats. You have to squeeze the teats to get the milk out.

Six-year-old Lewis made his knowledge of the function of the udders clear:

95. R. Let's have a look at the cow. What can you tell me about the cow?

96. L. Them things there (*points to the picture*) are for the baby calf to drink out.

Responses indicating shops or factories declined with age whereas the response, "cows" increased with age. Only one six-year-old child, having first said it comes from the milkman, was then able to give an organic origin for milk.

The findings in response to the two pictures, of milk and of a cow, are shown in figure 6.4.

Figure 6.4 Statements about milk (in response to two pictures)

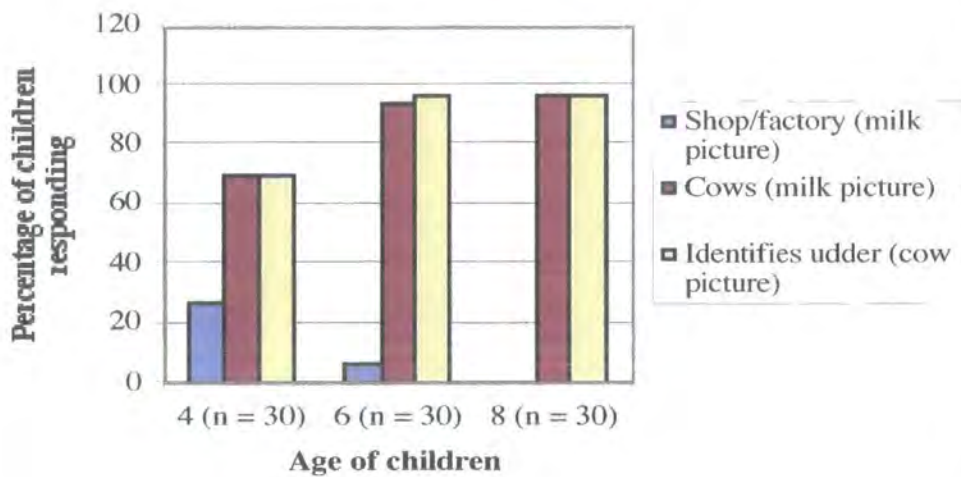


Table 6.3 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 10.96, which at 2 degrees of freedom shows that the age difference is significant at the 0.01 level ($\chi^2 = 10.96$, $df = 2$, $p < .01$).

Table 6.3 Statements about its origin in response to the milk picture

Age in years	Shop/no suitable response	Cows
4 (n = 30)	9	21
6 (n = 30)	2	28
8 (n = 30)	1	29

b) Uncooked vegetable items

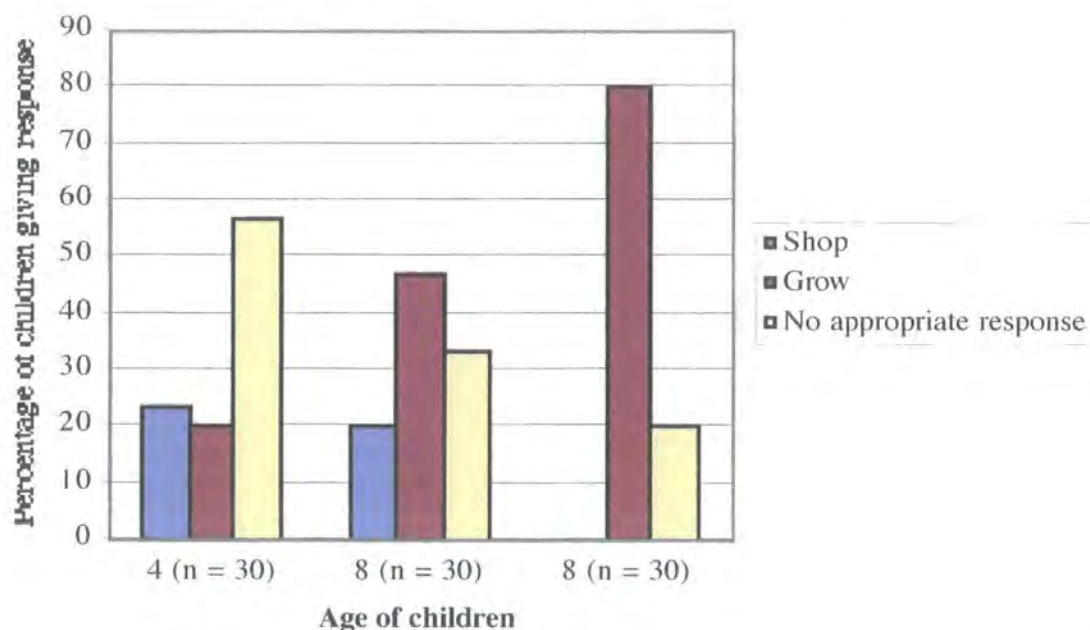
Lettuce

When children were shown the picture of lettuce and asked about its origin, two types of correct response, similar to those given for eggs and milk, were noted.

Children either stated that lettuce came from shops or indicated in some way that it was grown. Those nursery pupils who were asked where the shop might obtain lettuce were not able to indicate that it was grown, but instead gave an inorganic response, such as, “*from a factory*”. However, it was possible to persevere with the prompting of older children. Thus Mandy (aged 6 years), was reminded of the type of response required in the following exchange:

109. R. Do you know where lettuce comes from?
 110. M. A shop.
 111. R. Right. You know what I’m going to ask you next, don’t you? Where do the shops get them from?
 112. M. Men.
 113. R. And where do they get them from?
 114. A factory.
 115. R. And where does the factory get them from? You told me all this with the eggs, didn’t you?
 116. M. Shops.
 117. R. It all came down to chickens in the end, didn’t it? So what would this come down to, do you think? How would we start off if we wanted to get a lettuce?
 118. M. Plant it.
 119. R. Ah, right. We’d plant it. I think you know all about it. What would you plant?
 120. M. Erm, seeds.

Figure 6.5 Statements about the origin of lettuce



During the classification of the types of response relating to the origin of lettuce it was accepted that children knew that it was grown if they gave responses such as, “*from seeds*”, “*out of the ground*”, “*from the soil*” and “*from gardens*” as well as the

simple statement, “*they grow*”. The number of children who were able to indicate that lettuce had an organic origin increased with age. These results are shown in figure 6.5.

Table 6.4 Statements about the origin of lettuce

Age in years	Shop	Grow	No suitable response
4 (n = 30)	7	6	17
6 (n = 30)	6	14	10
8 (n = 30)	0	24	6

Table 6.4 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 23.32, which at 4 degrees of freedom shows that the age difference is significant at the 0.001 level ($\chi^2 = 23.32$, $df = 4$, $p < .001$).

Once more it was found that the younger children did not always reveal the full extent of their knowledge in response to this question. One four-year-old child who said that the lettuce seen in the picture came from a shop said later in the same interview that he had seen lettuce growing in his father’s garden. Similarly, a six-year-old who claimed to be ignorant of its origin later said he had seen lettuce growing in a neighbour’s garden.

Tomatoes

The same two types of response were noted as for lettuce. Either tomatoes came from shops or they were grown. Once more, the number of children who were able to indicate in some way that tomatoes have an organic origin increased with age. Such responses included, “*on a tree*”, and “*in a greenhouse*”, in addition to similar responses given for the origin of lettuce such as “*they are grown*”, and “*from seeds*”.

In similar fashion to the responses to the questions about lettuce, three four-year-old children who could not identify an origin for the tomatoes seen in the picture said they had seen tomatoes growing later in the interview, when asked if they had seen ‘anything you can eat, growing’. Converted to percentages, these results are displayed as a bar chart in figure 6.6.

Figure 6.6 Statements about the origin of tomatoes

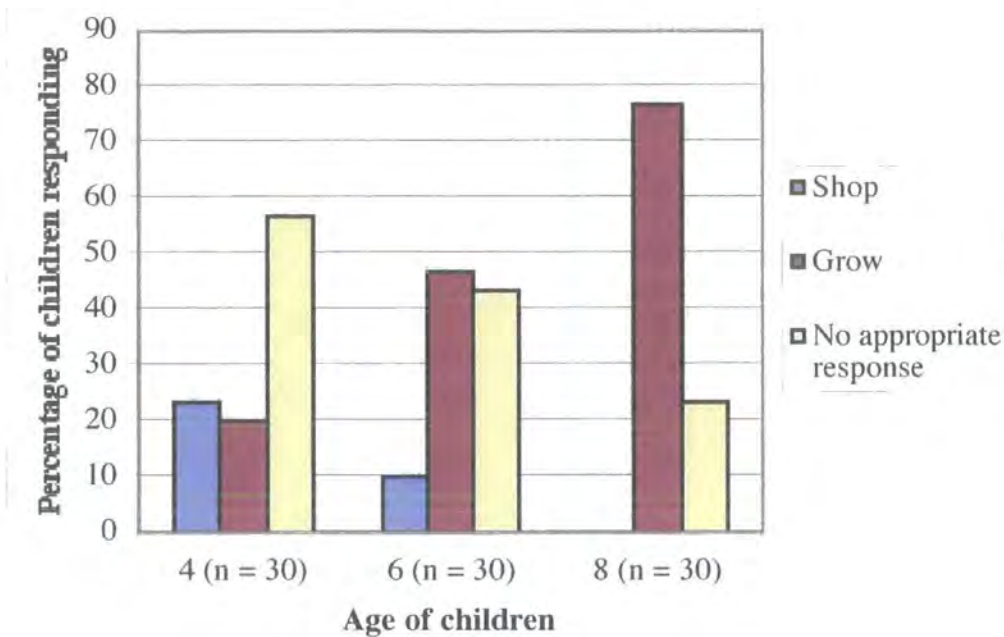


Table 6.5 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 21.61, which at 4 degrees of freedom shows that the age difference is significant at the 0.001 level ($\chi^2 = 21.61$, $df = 4$, $p < .001$).

Table 6.5 Statements about the origin of tomatoes

Age in years	Shop	Grown	No suitable response
4 (n = 30)	7	6	17
6 (n = 30)	3	14	13
8 (n = 30)	0	23	7

c) A processed food of animal origin: Cheese

Although cheese is a traditional food enjoyed by most of the children interviewed, they did not normally have the opportunity to see it being made from basic ingredients. It is not surprising, therefore, that none of the four-year-olds could

correctly name milk as its basic ingredient. Knowledge of its origin increased with age, as three of the six-year-olds and fourteen of the eight-year-olds knew this. Some of the younger children gave shops as the origin of cheese but none of the eight-year-old children did so. Several children made a reasonable suggestion, (such as butter, flour or pastry), for the main ingredient of cheese when asked to guess 'what might go in to make it'.

One four-year-old gave "mouse" as his response. Although there is an association for many adults between the words 'mouse' and 'cheese', it would be bizarre for an adult to suggest that cheese is made from mice! Two other four-year-old children made their mental association between mice and cheese plain. Thus Peter gave this response to questioning:

- 53. R. What's That? (*Shows picture*).
- 54. P. Cheese.
- 55. R. Cheese. Do you like cheese?
- 56. P. No.
- 57. R. No?
- 58. P. Mice like cheese.

Similarly, Ian, when asked whether he liked cheese, explained that:

- 60. I. Only mice like cheese. And my mammy.

The more reasonable suggestions for the ingredients of cheese are shown as percentages in figure 6.7.

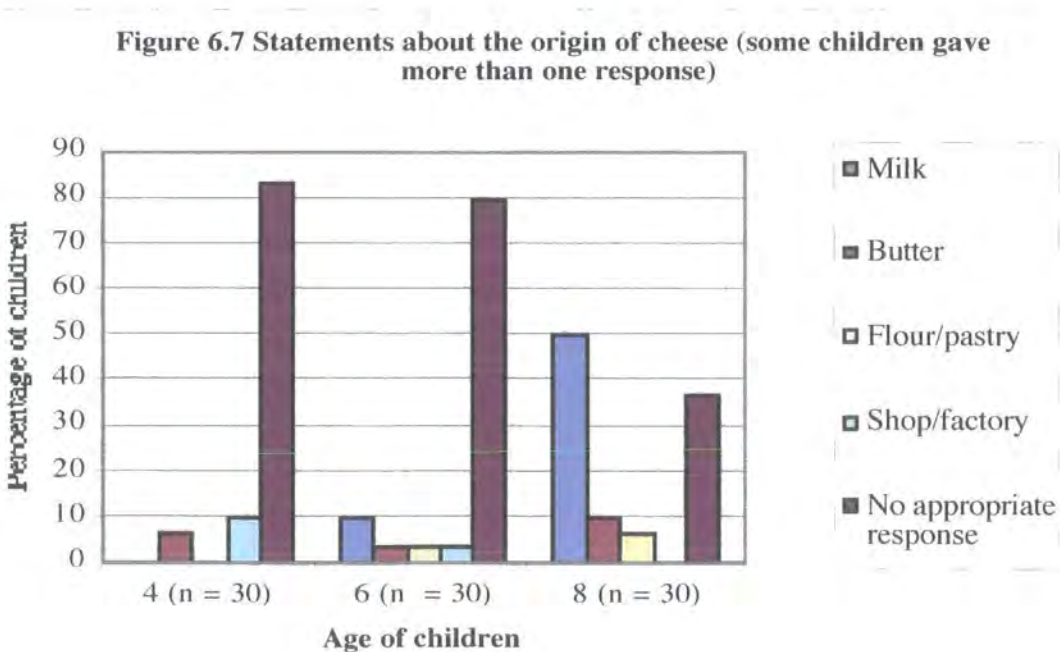


Table 6.6 shows the way the responses were cast for the purpose of the Chi-squared test. The result is 26.25, which at 2 degrees of freedom is significant at the 0.001 level ($\chi^2 = 26.25$, $df = 2$, $p < .001$).

Table. 6.6 Statements about the origin of cheese

Age in years	Milk	Incorrect/no suitable response
4	0	30
6	3	27
8	15	15

d) Processed food items of vegetable origin

Chipped potatoes

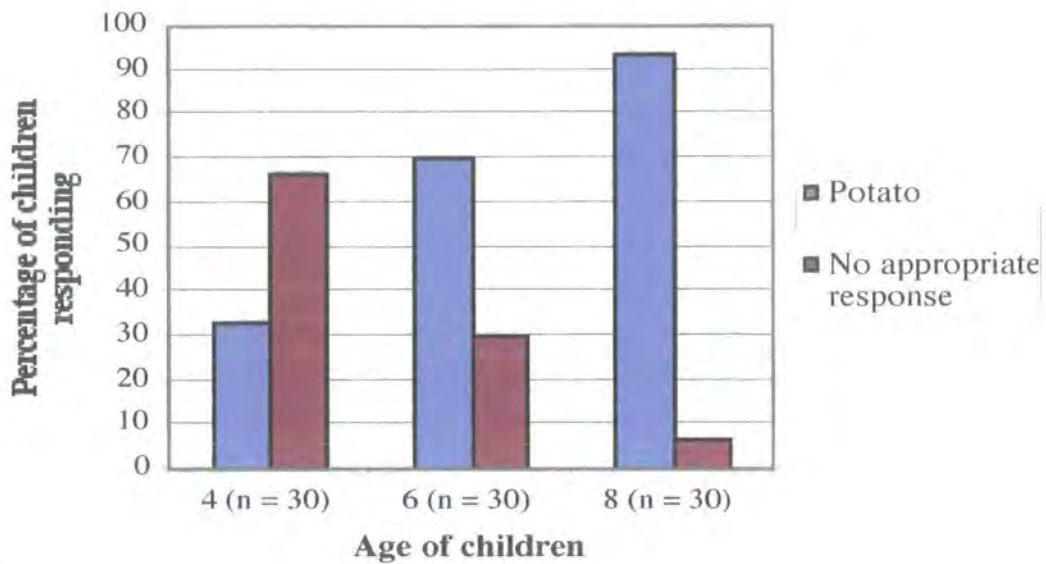
All except one of the ninety children interviewed claimed to enjoy eating chipped potatoes. However, when asked, ‘What are chips made from?’ there was a marked difference in age in the proportion of children who could say that they were made from potatoes. Two (one aged four and the other aged six years), could only say that chips are made from “*white stuff*”. The percentage findings are shown in figure 6.8.

Table 6.7 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 24.31, which at 2 degrees of freedom shows that the age difference is significant at the 0.001 level ($\chi^2 = 24.31$, $df = 2$, $p < .001$).

Table 6.7 Statements about the origin of chipped potatoes

Age in years	Potato	No suitable response
4 (n = 30)	10	20
6 (n = 30)	21	9
8 (n = 30)	28	2

Figure 6.8 Statements about the origin of chipped potatoes



At age six a typical exchange was that with Mandy, who correctly indicated that potato tubers grow at the base of the plant:

169. R. Do you know how we get potatoes?
 170. M. Grow them.
 171. R. Have you seen them growing?
 172. M. I've seen them on the telly.
 173. R. Right. You're doing well. Do you know which part of the plant the potatoes grow on, the ones that you eat?
 174. M. On the bottom.

By age eight, and with a little prompting, the responses were often both more accurate and more detailed, as the exchange with Stephanie illustrates:

247. R. Right, OK. Can you tell me where potatoes come from?
 248. S. The garden.
 249. R. Have you seen your Dad grow those?
 250. S. (Nods) And sometimes we get them from the shop.
 251. R. Right, OK. Whereabouts, ... can you tell me a bit about how potatoes grow? Because it's a little bit different from tomatoes or lettuces. Do you know what you start off with, what you plant?
 252. S. They don't start off with a little seed.
 253. R. No, they don't, do they? (*pause*) How would you plant potatoes?
 254. S. Don't really know.
 255. R. But you know it's not a seed? OK. Well you actually plant small potatoes, which we call seed potatoes. But they're not seeds. Have you ever seen potatoes starting to sprout and grow?
 256. S. (Nods).
 257. R. Where have you seen that?
 258. S. Sometimes in the garden, ...
 259. R. Mm.
 260. S. And sometimes, erm, in a bag in the groceries.

261. R. Yes. If you keep them too long, they start to sprout, don't they? And in fact, in a Year One class that I've just been in, they have some growing on the window sill. Do you know how you would get the potatoes, when you have grown them? Because it's not like lettuces. (pause). With lettuces, you pull them up, chop the bottom off, and they're ready to eat. But with potatoes, do you know what happens?
262. S. You need to wash them.
263. R. You do. But where abouts on the plant do they grow? That's really what I'm asking you. Do you know?
264. S. No.
265. R. You can't actually see the potatoes, when you go into the garden. You can't see if they're ready to pick. Because ... ?
266. S. It's got, because the little potatoes are like, ... all underground.
267. R. That's right. They're under the ground. So, the potatoes grow under the ground. (pause) Anyway, they do grow, like the other things we've been talking about.

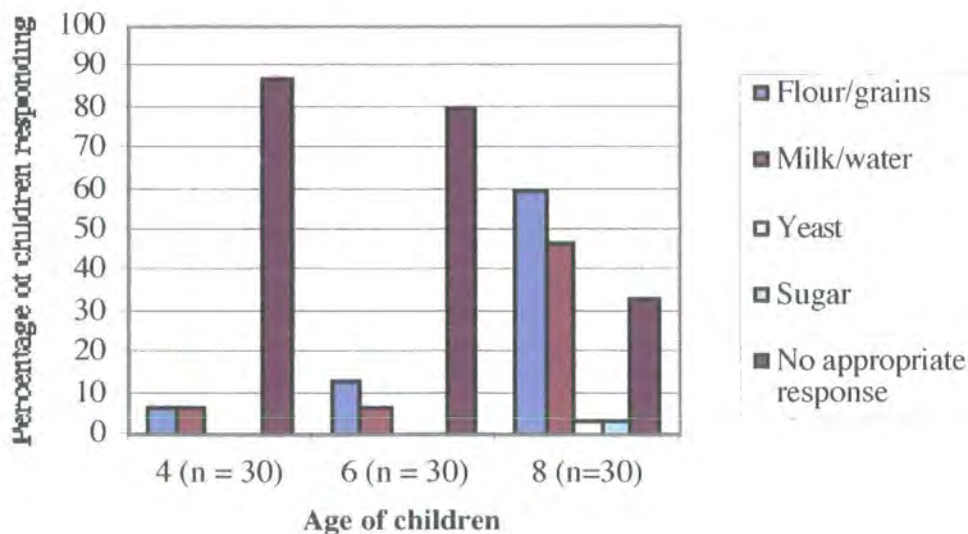
At age six years, four children could say that potatoes grew at the base of the plant or underground and at age eight years eleven children could say this.

Bread

Only three children, one at each age, claimed to have seen bread being baked at home. When asked, "What goes in to make it?" few of the younger children had any idea of its ingredients, although more than half of the eight-year-olds knew that bread was made from flour and either milk or water.

Only one child, an eight-year-old, correctly mentioned yeast. Only one, a six-year-old, correctly mentioned sugar. These results are shown as percentages in figure 6.9.

Figure 6.9 Statements about the ingredients of bread



Several children suggested more than one ingredient. Table 6.8 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 22.80, which at 2 degrees of freedom shows that the age difference is significant at the 0.001 level ($\chi^2 = 22.80$, $df = 2$, $p < .001$).

Table 6.8 Statements about the ingredients of bread

Age in years	one or more correct ingredients	No suitable response
4 (n = 30)	4	26
6 (n = 30)	6	24
8 (n = 30)	20	10

When wheat was mentioned it was possible to check the child's understanding of this ingredient as grain that grows in a field. A typical exchange with an eight-year-old is that with Stephanie:

277. R. Can you tell me what bread is made from?
 278. S. Wheat.
 279. R. Right. What can you tell me about wheat? What sort of a thing is it?
 280. S. It, er, grows in a field.
 281. R. It grows in a field. Right. Have you ever seen wheat growing?
 282. S. (Nods).
 283. R. What does it look like?
 284. S. It's like, this long stick, and, like, it's got little grains on.

Four-year-old Samantha apparently had no idea how to bake bread, but used her knowledge of turning bread into toast and sandwiches in order to respond to the question:

187. R. Now then, do you know how to make bread? How do you do it?
 188. S. Well, the ... There's a piece of bread. You cut it up.
 189. R. Mm. But if you didn't have any bread. How would you make the bread itself?
 190. S. We've got a toaster that, ... who makes bread.
 191. R. OK. What would you put in, to make it?
 192. S. I have to put cheese, salad and everything I want.

Corn flakes

Due to the large scale of the photograph, some children at first identified the corn flakes as potato crisps. However, they readily accepted the researcher's statement that they were indeed corn flakes, especially as close examination enabled them to

see some milk in the bowl with the flakes. Few of the four-year-olds had any idea of their origin. However, this was the only item for which several of the (mainly older) children stated that they were able to guess its origin from the name of the product.

Figure 6.10 Statements about the origin of corn flakes

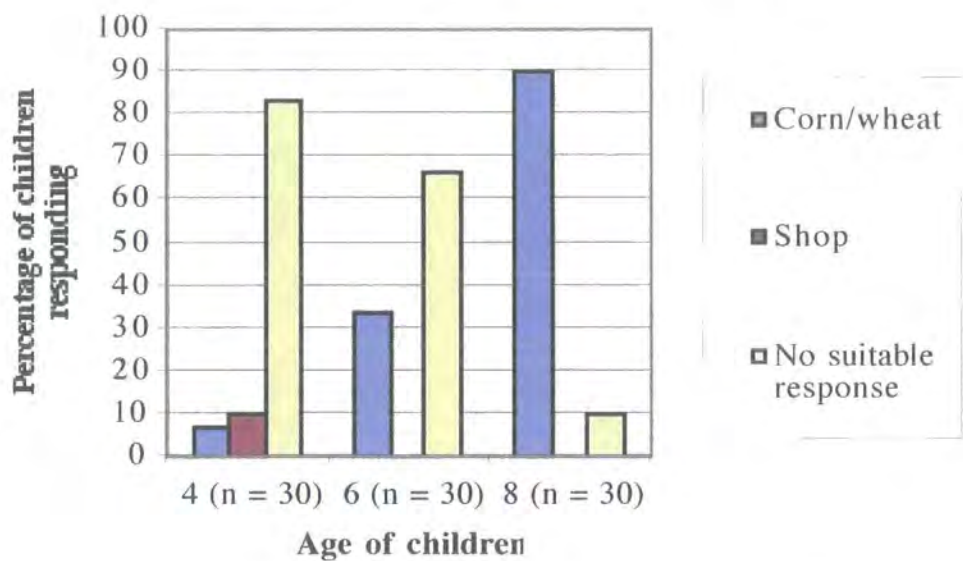


Table 6.9 Statements about the origin of corn flakes

Age in years	Corn/wheat	Shop/no appropriate response
4 (n = 30)	2	28
6 (n = 30)	10	20
8 (n = 30)	27	3

As for wheat, the researcher was able to check the children’s understanding of corn as grain that grew in a field. For example, eight-year-old Jamie responded as follows:

- 238. J. (*Looks at picture*) Corn flakes.
- 239. R. Mm. What are they made from?
- 240. J. Corn.
- 241. R. Mm. What’s corn?
- 242. J. Grains of wheat.
- 243. R. Right. Well, if it’s wheat flakes, it’s grains of wheat.

244. J. Mm. Corn's the same as wheat. But it goes golden, and it doesn't turn brown.
 245. R. Right. Yes. Those are big yellow grains. And the wheat is smaller, brown grains.

The findings are shown as percentages in figure 6.10. Table 6.9 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 44.25, which at 2 degrees of freedom shows that the age difference is significant at the 0.001 level ($\chi^2 = 44.25$, $df = 2$, $p < .001$).

6.3.2 Children's factual knowledge about food producers

Food for hens

Children were asked, when looking at the picture of hens, what these creatures might eat. The items they mentioned which were counted as correct were seeds, grass, bread crumbs, corn, worms, hay, nuts, meat, cheese, spiders, little animals, cabbage, plants and carrots. As was the case with other topics, many of the four-year-old children had difficulty in giving an appropriate response to this question. Even Suzie, aged eight years, who said that her grandfather has a farm, had difficulty in deciding what a hen might eat:

107. R. You said that chickens come from a farm, didn't you? Right. What would they eat if they were hungry?
 108. S. (*Very long pause*) I don't know.
 109. R. No? Can you guess? (*pause*) Say you had to look after them for a day, and you knew they were very, very hungry, what would you try them with?
 110. S. Erm, (*long pause*), erm, I would try them with nuts, and things like that. And if they didn't like them, I would just leave them.

Some children clearly had appropriate first-hand experience of seeing hens feeding. For example, six-year-old Christopher was able to describe the appearance of the grains of corn:

93. R. If those hens were hungry, what would you give them to eat?
 94. C. Corn.
 95. R. Oh, right. How do you know that?
 96. C. 'Cos I've seen chickens at the farm eating corn.
 97. R. Right. You didn't feed them yourself?
 98. C. No.
 99. R. No. Did you see somebody giving them some corn?
 100. C. (*Shakes head*).
 101. R. No? What does corn look like?
 102. C. Erm, er, little seeds.

Jill (aged eight years), was able to name two items she had seen being eaten by hens as a result of her own observation:

121. R. (*Looking at the photograph*) If the chickens are hungry, what do they eat?
 122. J. Er, little seeds.

- 123. R. Have you seen them being fed?
- 124. J. Yes.
- 125. R. And they also scratch around for their own food. What do they like?
- 126. J. Is it worms?
- 127. R. What made you think of that?
- 128. J. Because I've just seen them scratch around, at my friend's house.

Christopher (aged eight years) had stated earlier in the interview that he saw his father, who worked on a farm, at the weekends. Despite denying that he had seen hens being fed, Christopher was nevertheless able to name three suitable items in their diet and to describe the appearance of corn:

- 123. R. Can you tell me what hens eat?
- 124. C. They can eat grass, and worms.
- 123. R. Have you seen them eating?
- 124. C. No.
- 125. R. How did you know that?
- 126. C. I saw them on the telly, and me Mam tells us. And me Dad.
- 127. R. What does your Dad give them to eat?
- 128. C. He gives them this corn.
- 129. R. What does it look like?
- 130. C. They're little round things.

Ten children likened hens to birds when being asked about the food hens would eat. No obvious age difference could be seen in this response: three four-year-olds, four six-year-olds and three eight-year-olds made the connection. For example, Daniel, aged four years, described his experience of feeding and watering wild birds that come down from the trees, presumably to a bird table:

- 130. R. There are the chickens (*points to the photograph*). They live on a farm. What do the chickens eat, do you think?
- 131. D. Er (*long pause*), seeds.
- 132. R. Seeds. Right. have you seen any chickens being fed?
- 133. D. Er, erm, I seed birds, me.
- 134. R. Right.
- 135. D. *That chicken's being fed* (*points to the photograph*).
- 136. R. But you've seen birds being ...
- 137. D I've give them a drink.
- 138. R. Oh, have you? Right.
- 139. D. Yes, in a bait [feeding] box. Out of the trees.
- 140. R. Right. The birds out of the trees. You've given them a drink. Right.

Emma (aged six years) mentioned the similarity in appearance between hens and wild birds:

- 75. R. Now if those hens were hungry, what would you give them to eat?
- 76. E. Grass.
- 77. R. Grass. It looks as though they are eating grass there (*points to the picture*), doesn't it? Anything else, do you think they would like?
- 78. E. (*Pause*) Worms?
- 79. R. Yes. I think they would like worms. What made you think of that?
- 80. E. Because they look like birds.

Matthew (aged eight years) must have seen wild birds pull worms from the ground and so made the connection with hens:

- 73. R. If they [the chickens] were hungry, what would they eat?
- 74. M. Probably something like, er, grass.
- 75. R. OK. They might be pecking this grass that's there (*points to the picture*). If you were going to feed them, what would you give them to eat, do you think?
- 76. M. I'd probably give them grass.
- 77. R. Right. And they're scratching round. They actually pull worms out of the soil and eat those as well.
- 78. M. Like birds.

Children were not always able to explain the connections they had made. For example, six-year-old Adam probably used his experience of feeding garden birds with crusts when asked about the hens; although he could not say this:

- 71. R. If those hens were hungry, what would you give them to eat?
- 72. A. Crusts.
- 73. R. Crusts. Right, I think they'd like that. Anything else?
- 74. A. (*Shakes head*).
- 75. R. What made you think of crusts? Is there something you've fed, even if it's not hens, that likes crusts? That made you think of crusts?
- 76. A. (*Silence*).

One six-year-old boy seemed to make the surprising suggestion that hens are cannibals when asked what he would give them to eat:

- 98. G. [They would eat] chicken food.
- 99. R. What's that? What's in chicken food?
- 100. G. Some real chicken.
- 101. R. Some real chicken?
- 104. G. (*Nods*).
- 105. R. What do you mean? Dead hens, do you mean?
- 104. G. (*Nods*).
- 105. R. So if these hens were hungry, you'd have to kill some hens and then give them to them to eat? Is that what you mean?
- 106. G. I have got a gun in the house.

Some children, especially the four-year-olds, said that the hens would eat eggs. Two four-year-olds, two six-year-olds and one eight-year-old mentioned both suitable food items and eggs as items hens might eat. This response was surprising because most of the children had already indicated that hens such as those shown in the photograph themselves produced eggs. For example, Katy, aged four years stated this:

- 47. R. The farmer keeps them [the hens] in the field, doesn't he? And what do we get from the hens?
- 48. K. Eggs.
- 49. R. Eggs, that's right. I wonder what they eat? What if the hens were hungry. What would you give them to eat?
- 50. K. Eggs.

On the other hand, Andrew, a six-year-old, at first denied knowledge of the origin of eggs but suggested that hens would eat them. However, when he was probed further, he was able to say that hens lay eggs and then indicated that they would eat their own eggs:

- 49. Now if those hens were hungry, what would you give them to eat?
- 50. A. (*Long pause*) Don't know.
- 51. R. You don't know. If you were the only person around and you knew that they were very, very hungry hens, what would you try them with?
- 52. A. Eggs.
- 53. R. You'd give them eggs. Right. Where do we get eggs from?
- 54. A. Don't know.
- 55. R. You don't know, but you'd give them eggs to eat, would you?
- 58. A. Yes.
- 59. R. Right. So what do the hens give the farmer? Why does the farmer want to keep those hens?
- 60. A. So he can get food.
- 61. R. What sort of food?
- 64. A. Don't know.
- 65. R. Would the farmer get food from the hens? (*long pause*) Is that what you mean?
- 66. A. Yes.
- 67. R. Right. So what sort of food would you get from hens?
- 68. A. Eggs.
- 69. R. Oh, right. So when I asked you where those eggs (*re-shows the first picture*) might come from, do you mean those eggs?
- 70. A. Yes
- 71. R. They come from those hens.
- 72. A. Uh-huh.
- 73. Oh, right. Do they lay the eggs?
- 74. A. Yes.
- 75. R. Oh, right. I see. So you knew all the time, didn't you?
- 76. A. Yes.
- 77. R. Oh, right. So the hens lay these eggs (*points to the first picture*)?
- 78. A. Yes.
- 79. R. Right. OK. But when, when I said ... when you said to me that the hens would eat eggs, do you mean they would eat their own eggs?
- 80. A. Yes.
- 81. R. They'd eat their own eggs?
- 82. A. Yes.
- 83. R. Why would they want to do that?
- 84. A. Don't know.
- 85. R. OK (*shows the next picture*).

Despite that, four-year-old Patrick, who when looking at the photograph of the eggs (some of which were being fried in a pan) had said that they could hatch into little chicks, had second thoughts about the eggs that hens might eat:

- 131. If those hens were hungry, what would they have to eat?
- 132. P. Eggs.
- 133. R. Do they eat eggs?
- 134. P. Yes.
- 135. R. Their own eggs that they've laid?
- 136. P. Yeah. ... No.
- 137. R. So, which eggs do they eat, then?
- 138. P. Normal eggs that, ... Normal eggs that ... that don't hatch.
- 139. R. Normal eggs that don't hatch. Do you think they eat anything else?
- 140. P. No.

Of the six four-year-old children who mentioned eggs as a suitable food for hens, only one attended a Sea View nursery. Whereas Sea View nursery pupils had seen eggs being incubated and hatched, Manor House nursery pupils had not. Therefore it seems likely that children who had first-hand experience of incubation and hatching were less likely to view eggs as appropriate food for adult hens. A psychological explanation for this surprising response is suggested in the discussion section of this chapter.

The percentage of children giving these responses at each age is shown in figure 6.11. Some children gave more than one response.

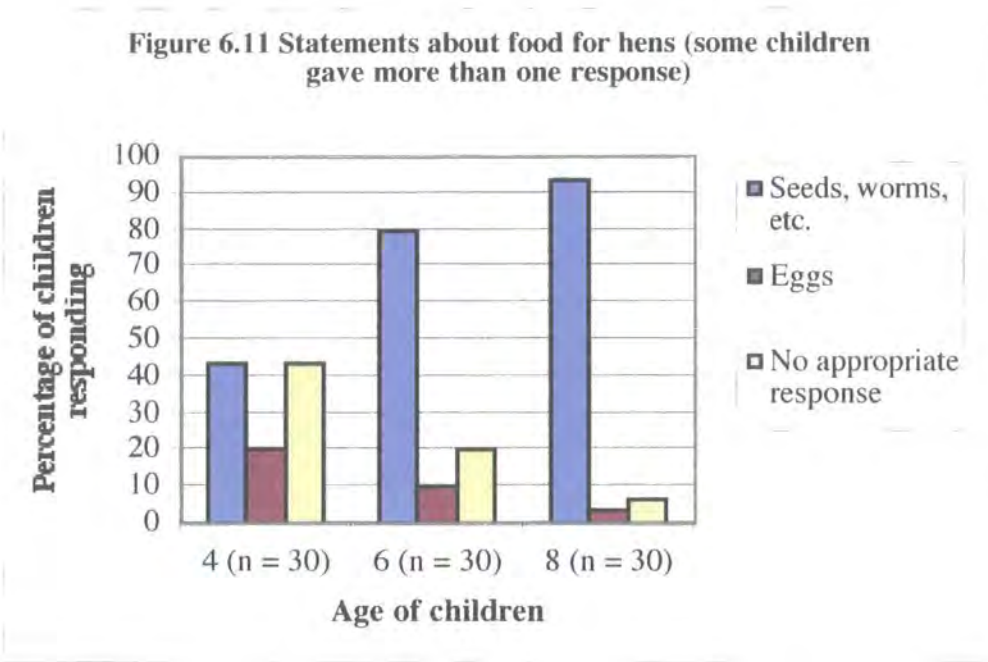


Table 6.10 shows the way the responses were cast for the purpose of the Chi-squared test.

Table 6.10 Statements about food for hens

Age in years	Seeds, worms, etc.	No appropriate response
4 (n = 30)	13	17
6 (n = 30)	24	6
8 (n = 30)	28	2

This yields a value of 20.05, which at 2 degrees of freedom shows that the age difference is significant at the 0.001 level ($\chi^2 = 20.05$, $df = 2$, $p < .001$).

Food for cows

One of the questions children were asked when shown the picture of a cow was about their food. Nearly all the children at all ages could say that cows ate grass. Since the cow in the picture was shown eating grass, this was to be expected. However, three of the younger children indicated that cows also use milk for food. This was surprising because at that stage of the interview the children had already seen the photograph of milk and stated that milk was produced by cows. The exchange with four-year-old Kate clearly illustrates that she knew the cow in the picture produced milk, yet she stated at the same time that it fed upon milk:

58. K. (*On being shown the picture*) Erm, a cow.

59. R. A cow, that's right. And you told me that milk comes from the cow didn't you? Right, what part of the cow does the milk come from?

60. K. Erm (*pause*).

61. Do you know that? Can you point to the part where the milk comes from on the cow? Mm?

62. K. No.

63. R. You can't. Right, you get milk from the cow. That's the part that makes the milk (*points to the picture*), the cow's udder, there. And those are the teats. You squeeze those to get the milk out.

64. K. Yeah.

65. R. Right, and what does the cow eat?

66. K. Erm, milk.

Thus it appears that Kate knew that she is talking about an adult cow that itself makes milk, not a calf, when she stated that the cow used milk for food.

Six-year-old Gavin said he had seen milking on TV and pointed to the cow's udder as the part of the cow that makes the milk. He then stated that the cow would drink milk:

141. R. You've seen them milking the cow on the telly. If this cow was hungry, what would you give it to eat?

142. G. Some milk.

143. R. Some milk. Right. where would you get the milk from?

144. G. Out of there (*points to udder*).

The researcher then discussed the cow shown in the picture eating grass before attempting to make certain that Gavin was thinking of an adult cow who drank milk:

159. R. Does it drink its own milk?

160. G. Uh huh.

161. R. How does it reach back there to get its own milk?

162. G. It has to run. Yes.

Some of the other children who stated that cows drank milk were in fact thinking of calves. For example, six-year-old Sky, who at first stated that cows drank milk, was able to explain that she was really thinking of calves:

- 136. R. What does the cow eat when it's hungry?
- 137. S. Grass.
- 138. R. Grass. It's eating grass there (*points to the picture*), isn't it? Does it eat anything else?
- 139. S. Milk.
- 140. R. It eats milk, does it? Right. Where does it get the milk from?
- 141. S. The babies.
- 142. R. It gets milk from the babies?
- 143. S. The babies get the milk from their mummies.

Six-year-old Sophie, who had stated that cows made milk earlier in the interview, described feeding a lamb milk from a bottle, at first stated that the adult cow in the photograph would drink milk but then indicated that only the babies would do this:

- 107. R. What does the cow like to eat?
- 108. S. Grass.
- 109. R. It's eating grass there, isn't it? Do cows like to eat anything else?
- 110. S. Milk.
- 111. R. The cow makes the milk, but it also likes to eat milk, you said. Does the grown up cow eat milk, or just the babies?
- 112. S. The babies.

Six-year-old Kimberley said that cows drink milk. Nevertheless, she must have been thinking of adult cows being milked and then calves being fed the milk from a bucket:

- 116. R. Show me which part [you get the milk from] in the picture.
- 117. K. (*Points to udder*).
- 127. R. How do you know about that?
- 128. K. Because I saw them.
- 129. R. You've seen it happen?
- 130. K. I saw some cows drink some milk.
- 138. K. Me dad goes to work and he feeds the cows.
- 139. R. Your dad goes to work and he feeds the cows?
- 140. K. Yes.
- 141. R. What does he give them to eat?
- 142. K. Milk.

Altogether, three children appeared to mean that cows, rather than calves, use milk for food. One four-year-old, Lee, at first stated that cows eat beef, but then changed his mind:

- 105 R. Now, (*showing the photograph of the cow*) when the cow's hungry, what does the cow eat?
- 106. L. Beef.
- 107. R The cows eat beef?
- 108. L. Nah! All grass.
- 109. R. It eats grass. So you were kidding, weren't you?
- 110. L. Yeah!

The findings are shown as percentages in figure 6.12.

Figure 6.12 Statements about food for cows (one child gave more than one response)

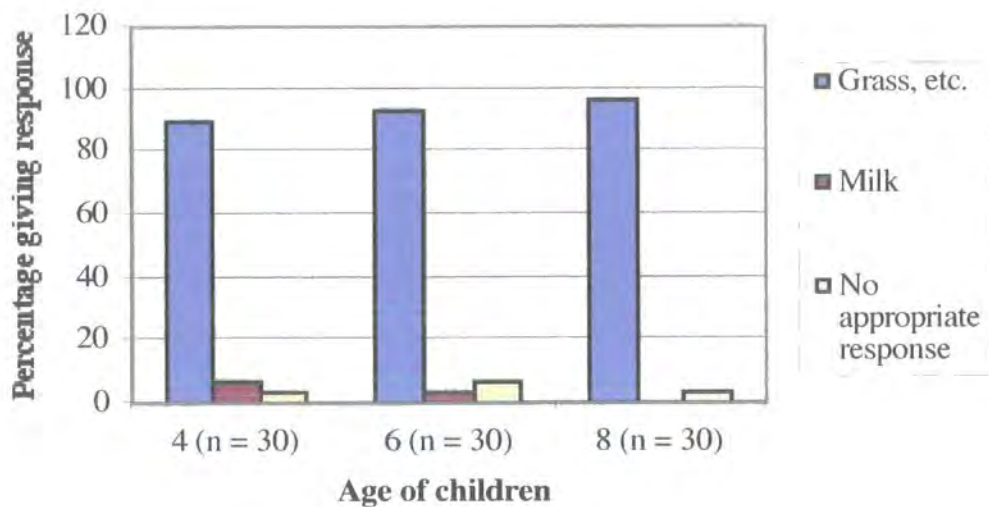


Table 6.11 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 1.07, which at 2 degrees of freedom shows that the age difference is not significant, even at the 0.5 level ($\chi^2 = 1.07$, $df = 2$, ns).

Table 6.11 Statements about food for cows

Age in years	Grass, etc.	No suitable response
4 (n = 30)	27	3
6 (n = 30)	28	2
8 (n = 30)	29	1

The needs of plants

As explained in chapter five, plants produce their own food by the process of photosynthesis. This food is necessary for life processes, including growth. The raw materials for this process are carbon dioxide from the air and water from the soil. Light from the sun provides the energy needed for these chemical changes. To be

sure, it is unreasonable to expect young children to have a full understanding of photosynthesis but they can be asked about the conditions needed for plant growth. This was done whenever an opportunity arose. In some interviews the opportunity occurred when children described the cultivation of lettuce or tomatoes. In others the opportunity to ask the question was not presented until the last picture, of onions growing in a garden, was shown. Children were asked what seedlings would need to “help them to grow”.

By far the most common item mentioned at all ages was water. Children were then prompted by being asked what else might be needed. Two other requirements commonly identified as necessary for growth were the sun and soil. Those children who mentioned the sun were asked why it was needed, in order to determine whether they knew about the need of plants for light. As a result of this probing, six-year-old Emma could not say exactly why a seedling needs sunshine:

- 264. E. [Seedlings need water and] sunshine.
- 265. R. Sunshine. What does the sunshine do for them?
- 266. E. Makes them push their way up.

However, one six-year-old and one eight-year-old mentioned warmth and four eight-year-old children mentioned light as aspects of sunshine that are utilized by plants.

When they were asked what else plants might need, seven children mentioned fertilizer in some form (for example, “*boxed food*”) but there was no obvious age difference for this item. Only one six-year-old suggested oxygen and one eight-year-old mentioned air.

The percentage of children who identified each item is shown in figure 6.13. As explained, many children mentioned more than one item.

In order to conduct the Chi-squared test on these results, only the children who first identified water as necessary for plants were included. Of these, two groups could be identified: those who also mentioned the Sun and those who did not. Table 6.12 shows how these findings were cast for the purpose of the Chi-squared test. Therefore, unlike the other tables in this chapter, the total number of children at each age was not exactly matched. The test yields a value of 12.38, which at 2 degrees of freedom shows that the age difference is significant at the 0.01 level ($\chi^2 = 12.38, df = 2, p < .01$).

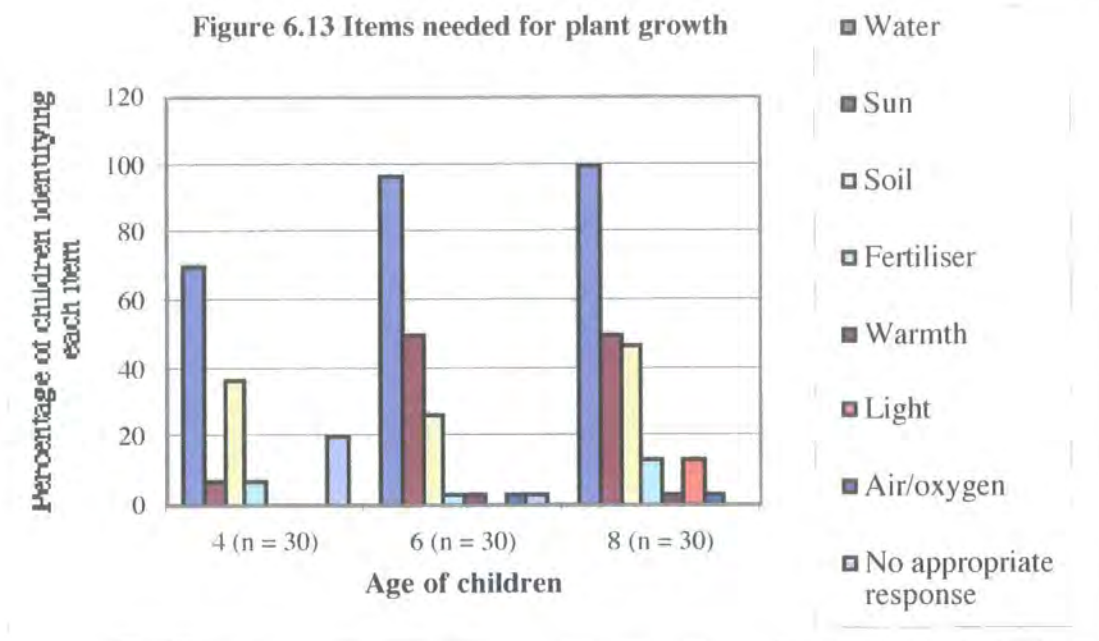


Table 6.12 Items needed for plant growth (some children mentioned several items)

Age in years	Sun mentioned	Sun not mentioned
4 (n = 23)	2	21
6 (n = 29)	15	14
8 (n = 30)	15	15

6.3.3 Children’s understanding that plants are the ultimate source of food

The final question put to the children was designed to discover whether they appreciated that all human food depends ultimately upon plants. In the light of their previous responses it was decided that questioning about this was too abstract for the four-year-old children. Therefore only the six- and eight-year-old children were asked what would happen if all the plants died.

Despite the fact that the interview itself offered a series of clues for the correct answer to this question, many children simply replied that they did not know. This was especially so in the case of the six-year-olds. For example, Stephanie (aged eight years) responded to prompting in the following way:

317. R. This is the last picture, now.
 318. S. Onions.
 319. R. Yes, onions growing. And you know about that then, don't you? Now, you know that quite a lot of the things that you eat you can actually grow in your own garden. We've talked about getting food from animals that make extra things, so that we can eat them. Or we might actually eat the animal itself. Now, what I want to ask you is, if we couldn't grow anything. If all the plants stopped growing, what would we do for food?
 320. S. (*Long pause*).
 321. R. Any ideas, what we would do? (*pause*) Say the sun stopped shining, and the plants couldn't grow, what would we do for food?
 322. S. We have to grow it in our own garden.
 323. R. If the sun stopped shining, would they be able to grow?
 324. S. No.
 325. R. Have you ever tried growing something in a dark place?
 326. S. (*Nods*).
 327. R. What happens?
 328. S. It grows like a (*inaudible*).
 329. R. It grows long and thin, doesn't it? Searching for the light. And then eventually, it dies. So if we couldn't grow anything at all, what would we do for food?
 330. S. Erm, (*pause*) erm, (*long pause*) I don't know.

Some children said they would buy food from the shops. Many of the eight-year-old children gave only a partial answer to this question. For example, some said they would grow their own vegetables or eat meat. Even when reminded of some of the information they had given earlier in the interview, they were unable to apply reasoning in order to reach a full explanation. On the other hand, a few children realised immediately that everyone would starve or die. For example, six-year-old Stuart responded in this way:

279. R. If we couldn't grow anything to eat, what would we do for food?
 230. S. Nothing.
 231. R. Nothing at all?
 232. S. No.
 233. R. That would be terrible, wouldn't it?
 284. S. Yes. We would die.

However, some children were able to give a reasoned response to the query when prompted. When they were reminded that without either sun or rain even the plants in their own gardens would die or that the animals which produce meat depend upon plants for food, some children realized that everyone would starve or would die. For example, James (aged eight years) engaged in this exchange:

283. R. If the sun stopped shining, And the plants couldn't grow, ...
 284. J. They would all drown.
 285. R. They'd all die, wouldn't they? What would we do for food, then?
 286. J. There would only be certain types of food that could be made.
 287. R. What sort of food would that be?
 288. J. Like, processed food.
 289. R. Right. What does processed mean? Can you tell me any of these things that we've looked at, that are processed?
 290. J. Cheese.
 291. R. Right. OK. So you know where that comes from, don't you?

292. J. Yes. A cow. Only food that comes from, like, any animal. We'd only be able to eat lamb, pork and beef. With our meat.
293. R. Mm.
294. J. Cheese. Cheese and yogurt is dairy food.
295. R. And they all come from cows, don't they? Right. OK. So if there were no plants, we would be able to eat food from animals, wouldn't we? And what about the animals themselves? What would they eat?
296. J. Grass.
297. R. What have we just said, though?
298. J. They wouldn't be able to eat anything. They'd have to eat leaves from trees.
299. And would the trees be all right, if there was no sun?
300. J. They would die. They'd need some water to grow. Then the cows would die.
301. R. Right.
302. J. Then we would die.

A summary of children's final responses is shown in figure 6.14.

Figure 6.14 Children's ideas about the effect of plant death

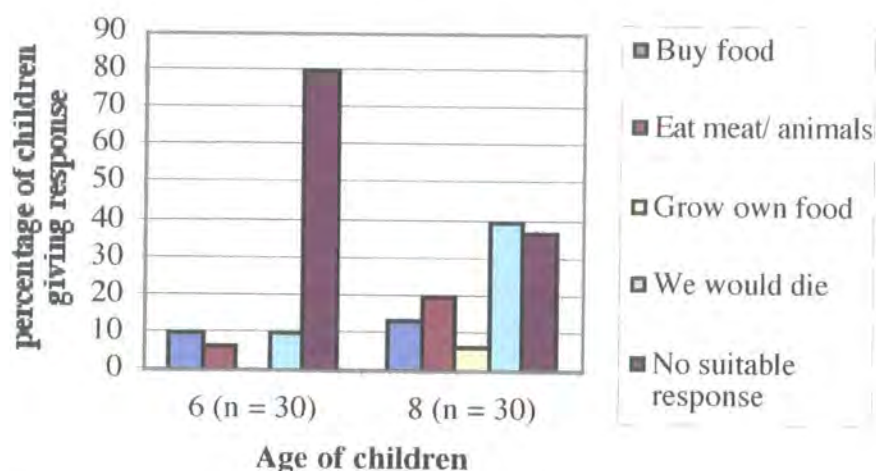


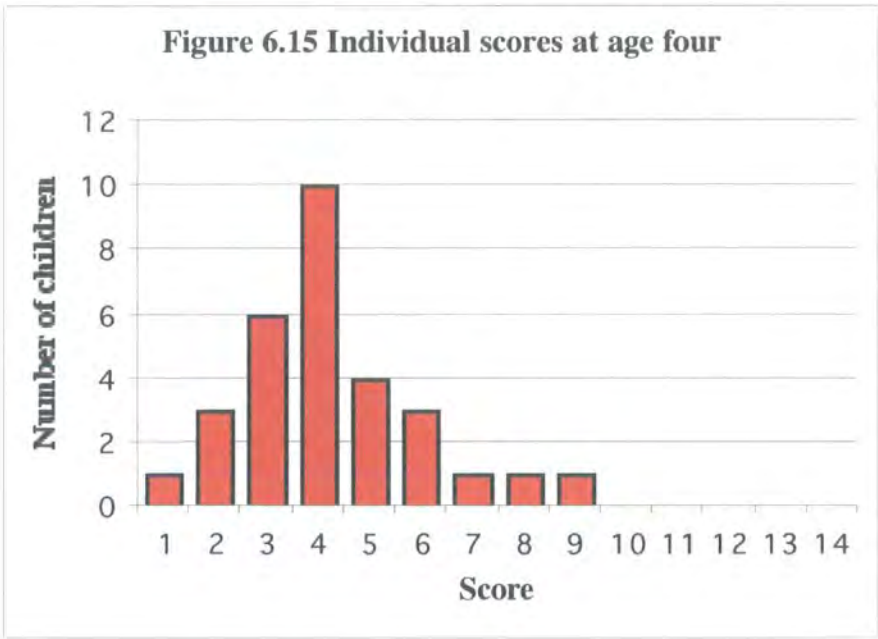
Table 6.13 shows the way the responses were cast for the purpose of the Chi-squared test. This yields a value of 7.20, which at 1 degree of freedom shows that the age difference is significant at the 0.01 level ($\chi^2 = 7.20$, $df = 1$, $p < .01$). With application of the Yates' correction (which it was explained in chapter five provides a more conservative calculation), the Chi-squared value is 5.68, indicating significance only at the 0.05 level ($\chi^2 = 5.68$, $df = 1$, $p < .05$).

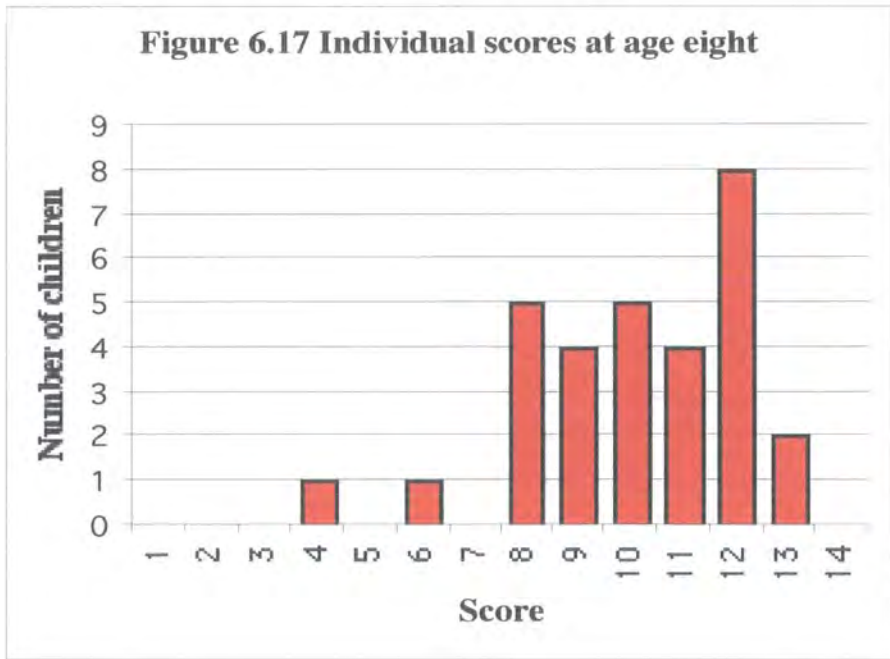
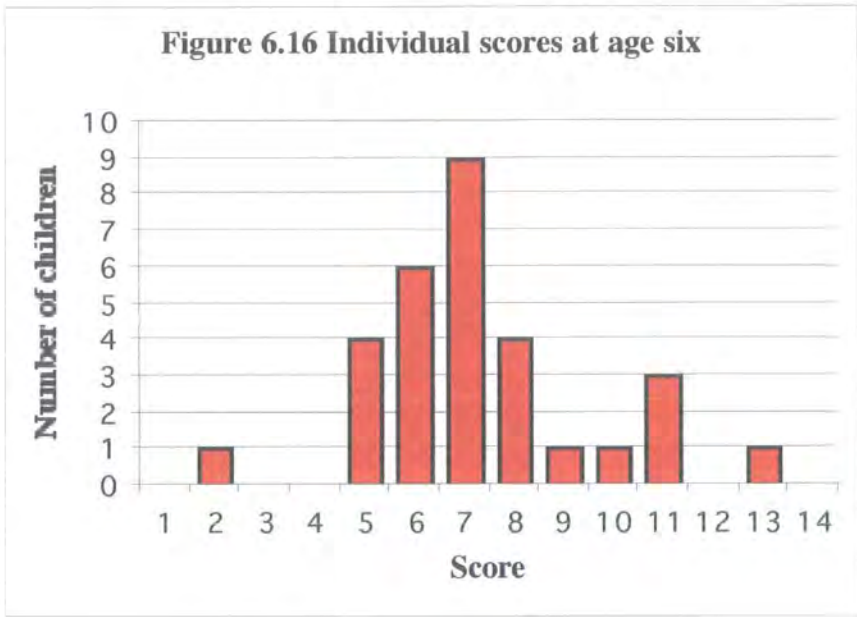
Table 6.13 Children’s ideas about the effect of plant death

Age in years	We would die/ have no food	Shops/no suitable response
6 (n = 30)	3	27
8 (n = 30)	12	18

6.3.4 Analysis of responses by individual children

As explained in chapter five, each child was given a score for the number of correct responses given to factual questions about the origin of human and plant food. The frequency of the scores gained by individual children is illustrated by means of a bar chart for each of the three age cohorts (figures 6.15 - 6.17).





As explained in chapter five, the knowledge scores for individual children provide interval data. It was therefore possible to carry out four statistical tests upon them, grouping the children for age, gender, location (Sea View or Manor House), and to demonstrate understanding in response to the final question.

Test for the significance of changes with age

It is expected that children will demonstrate more factual knowledge as they grow older. This appears to be the case, as the mean (average) individual scores of the four-year-old children is 4.2; of the six-year-old children 7.36; and of the seven-year-old children 10.5. In order to test the level of confidence that can be placed upon this idea an analysis of variance (ANOVA) test was conducted upon the scores of the children at the three ages. The ANOVA test demonstrates a highly significant age-related difference at the 0.001 level of confidence. $F = 56.448$

Critical F value $.99F_{2,87} = 1.406$

Test for gender difference in scores

A t-test of individual scores was conducted in order to determine whether there is a significant gender difference in the scores of the pupils in this study.

Critical $t = .95t_{88} = 1.662$

$t = 0.615$

Therefore the difference between the scores of boys and girls is not significant.

Test for school difference in scores

As explained in chapter five, there was a socio-economic difference between the Manor House and Sea View locations. Therefore a t-test of individual scores of children grouped by location was conducted in order to determine whether there was a significant difference between the scores of pupils attending Sea View and Manor House schools.

Critical $t = .95t_{88} = 1.662$

$t = 0.6877$

Therefore the difference between the scores of children at the two locations is not significant.

Test for score difference in children who demonstrated understanding

The final question, unlike the previous knowledge-based questions, was designed to probe understanding. As explained earlier, this question required children to be able to deduce that if all the plants died there would be no food for humans. It might be reasonable to assume that the possession of more factual information would result in better understanding. Therefore a third t-test was conducted upon the scores of the eight-year-old pupils. This was in order to determine whether there is a significant

difference between the knowledge scores of those children who answered the final question correctly and those who did not. In effect, this tests the idea that there is a positive correlation between relevant factual knowledge and understanding about the organic origin of food.

Critical $t = .95t_{28} = 1.701$

$t = 0.247$

Therefore there is not a significant difference between the scores of those children who demonstrated understanding that ultimately humans depend upon plants for their food and those who did not. This result leads to the conclusion that factual knowledge is not a sufficient prerequisite for understanding.

6.3.5 Children's response to the interviews

Large-scale responses

It is not easy to keep very young children on task for a long period of time. Especially with the nursery pupils it was not possible on many occasions to work through the complete protocol uninterrupted as subjects displayed numerous diversionary tactics. For example, one four-year-old boy said, "I am a tractor," and proceeded to jog round the interview room making appropriate "chug, chug, chug," noises before resuming the interview. In such cases, the next picture was shown in order to maintain interest.

The eight-year-old children were so excited about the project that they began to ask the first individuals to be interviewed what questions had been asked and the content of the pictures. The teacher then intervened. She explained that children must contain their curiosity until their own turn for interview, as prior knowledge of the questions would spoil the research findings.

Discourse analysis

As explained in chapter five, the intention for the semi-structured interviews was to make them as close to a normal conversation as possible rather than to conduct them in the form of a test. Consequently, the children themselves were able, to some extent, to influence the conduct of the interviews. The aspect of discourse analysis termed conversation analysis (described in the previous chapter), was applied to the transcripts in order to search for age-related differences in the exchanges between individual pupils and the researcher.

This analysis reveals that the researcher-pupil exchanges were not, in fact, similar to normal conversation but instead bore more resemblance to classroom interaction

“where the exchanges are typically elicitation-response-feedback” (Cameron, 2001: 49). Thus the researcher asked a series of elicitation questions using the photographs as stimuli. However, the difference here was that the researcher did not provide feedback as to the correctness or otherwise of the response but instead merely repeated the response or included the word, “*Right*”. Study of the original tape-recordings shows that “*Right*” was said in a non-committal but encouraging tone rather than in a more emphatic and affirmative way which might have indicated that the response was factually correct. The researcher did not (as a teacher would do), proceed to tell the children what the correct answer might have been. The researcher’s purpose was to gain information whereas “one of the teacher’s major functions in responding to pupil replies is that of distinguishing right from wrong” (Coulthard and Brazil, 1992: 66).

What is taken for granted in both conversations and teacher-pupil exchanges is that there will be a continuity of meaning in the content of the exchanges. An obvious breach of this expectation occurred in that some of the children’s responses bore no relevance to the researcher’s questions. There was a noticeable age difference in the number of irrelevant statements made by the children. These were common among the four-year-old children, rare among the six-year-olds, and absent in the eight-year old children. In fact, thirteen of the four-year-old children made statements that were totally irrelevant to the subject in hand, whereas only two of the six-year-olds did so. An example is that of four-year-old Kirsty, who said in response to the picture of lettuce: “My guinea pig eats chocolate”. While it might be conceded that Kirsty might have made a mental connection between her guinea pig and lettuce before mentioning another item in her pet’s diet, her response became even more irrelevant when she was asked, “Have you seen anything you can eat, growing anywhere? Perhaps in someone’s garden?” She replied with the statement, “We’ve got a story about Burglar Bill, and he pinches someone’s hat”. Kirsty made eleven irrelevant statements altogether.

Although the mean number of irrelevant statements per child was only 3.8 in those four-year-old children who made them, they did interrupt the flow of the interview and served to distract the researcher from pursuing the planned questions. The frequency with which irrelevant statements were made by four-year-old children is shown in Table 6.14

Table 6.14 Frequency of irrelevant statements made by thirteen four-year-old children

Number of irrelevant statements made	Number of children
1	2
2	4
3	3
4	1
7	1
8	1
11	1

The main topic of the irrelevant statements were details of the child’s family. For example, one child said, “My dad is thirty-five years old”. Another irrelevant topic were questions about objects in the interview room. For example, one child asked about some toys for toddlers that were stored, saying, “Do those baby toys belong to the nursery?” Objects seen through the window also featured as an irrelevant topic. For example, the cars in the staff car park. In contrast, of the two of the six-year-old children made irrelevant statements, one did so on one occasion and the other twice.

To be sure, many of the other four- and six-year-old children managed to make links between the topic of the interview and their personal concerns. These evoked a conversational response on the part of researcher. For example, when six-year-old Ashley was asked whether she liked to eat fried eggs, the following dialogue took place:

- 14. A. (*Looking at the photograph of eggs*) I ‘ad one of them eggs when I went to Whitby.
- 15. R. When you went to Whitby you had a fried egg, did you?
- 16. A. Mm.
- 17. R. Was that when you went on your holidays?
- 18. A. No.
- 19. R. Just a day trip?
- 20. A. I went for the day.
- 21. R. Right. Lovely.
- 22. A. I went with Mam and Carlene.
- 23. R. Oh, did you?
- 24. A. I went with my cousins and my sister.

This conversation continued for twenty-nine more exchanges, mainly about the fully-rigged sailing ship that was in harbour at the time of the visit, until the topic of eggs was resumed in the following way:

53. R. Right. Did you have fish and chips while you were there?
 54. A. No.
 55. R. No. (*Remembers Ashley's statement on line 14*) You had egg and chips, didn't you?
 56. A. (Nods).
 57. R. Right. Can you tell me where eggs come from?

Some links left the researcher speechless. For example, four-year-old Jamie's response to the photograph of the cow was: "*That cow's from Newcastle, 'cause it's black and white. Black and white, black and white, black and white,*" demanded a mental reorientation from milk and eggs to the colours of Newcastle's football team.

The topic of these interruptions perhaps indicates the intention (albeit subconscious) of the child to move the conversation onto a topic where s/he felt more at ease.

Given the difference in age and position of power of the two participants, these conversations promoted exchanges where the children were on as much an equal footing as possible with the researcher. Unfortunately they also caused the researcher to forget an intended question from time to time. Another reason for the omission of an intended question was the researcher's observation of a child's body language, indicating lack of engagement with the picture under discussion. On these occasions, the next picture was shown in order to revive the child's interest in the interview and encourage participation through to the last picture.

6.4 Discussion

The results reported here show the difference in children's responses relating to the organic origin of food at age four, six and eight. Clearly children already had a good deal of knowledge by the age of four. The four types of response found in the literature are illustrated in the findings presented in this chapter:

- a) a significant increase in factual knowledge with age,
- b) growth in understanding with age,
- c) intriguing responses offered by the youngest children but seldom by older ones,
- d) responses which could provide the basis of misconceptions that interfere with future learning in science.

In addition, a decrease in the frequency of irrelevant responses is noted. This factor is recorded in the present study but was not mentioned in the literature reviewed in the first part of this thesis.

Statistical tests indicate that the children's knowledge scores do not differ significantly by gender or locality. Furthermore, in the eight-year-old children, there

is no significant correlation between a) their score for knowledge of the origin of food items and b) their understanding of humans' ultimate dependence upon plants for food.

Of course, it is not remarkable that children's responses changed with age. As Karmiloff-Smith remarks:

The enticing yet awful fact about child development is that children do develop! Awful, because it has provoked a plethora of studies, totally unmotivated theoretically, accepted for publication in certain types of journal because the results are 'significant' - significant *statistically* since it is indeed easy to obtain differential effects between, say, five and seven year olds, but questionable as to their significance *scientifically*.

(Karmiloff-Smith, 1981: 151)

Nevertheless, she underscores the importance of extracting meaning from the data. This discussion is therefore designed to explore scientific explanations for the findings reported here.

6.4 1 Increase in knowledge

Responses to all the factual questions put to the children indicate an increase in knowledge as they grow older. Furthermore, when it is appropriate to conduct them, results of the chi-squared tests show that these findings are significant.

It should be noted, however, that the scores are not the same for each food item. Thus more children at each age gave correct responses for the origin of the raw food items (eggs, milk, meat, lettuce and tomatoes) than for the ingredients of processed items (chipped potatoes, bread, corn flakes and cheese), indicating greater knowledge of the origin of uncooked items. Children were more knowledgeable about the food of cows than they were about the food of hens. Also, whereas most children knew that seedlings need water, few could identify other requirements such as light and air. Neither is the level of significance of the increase as shown in the chi-squared tests the same. Another way to state this is to say that the rate at which children gain knowledge is not identical for every food item.

An obvious explanation for these differences in the rate of knowledge gain about the origin of food items is the difference in the opportunity to learn about each item. As noted by Gellert (1962), whose work is mentioned in chapter three, those items for which children have access to evidence from their own experience are likely to be

the ones for which the greatest number of correct responses are given. This explanation is explored in the third part of the thesis. The opportunities for children to see (and possibly assist in) vegetables being grown, to see or help in the feeding of cows and hens, to take part in food preparation and to care for plants are all the subject of inquiry. Relevant information about the origin of food items is also present in picture books, video films and in computer programs for young children. Furthermore, explanations may be given by teachers and by people outside school. Children's utilisation of these secondary sources of information is also explored in the third part of the thesis.

A different source of information allowed many of the older children to give an appropriate response to the question of the origin of corn flakes. They correctly stated that a clue is to be found in the name itself.

6.4.2 Growth in understanding

An appropriate response to the final question in the semi-structured interviews (relating to an understanding of the effect of plant death upon the human food supply), appears to require factual knowledge of the origin of food. Therefore it was anticipated that most understanding would be demonstrated by those children who had the highest knowledge scores. However, there was no statistical correlation between the number of relevant facts known by children and their demonstration of understanding. There are two possible explanations for this.

One explanation for this is to be found in the constructivist model for the development of understanding outlined in chapter two of the thesis. According to this account, the ability to perceive a conceptual relationship among a number of factual items depends upon the formation of appropriate mental links among the different knowledge items, thus forming a conceptual structure. If this explanation is correct, knowledge of some separate components of the concept is necessary but is not sufficient for the concept to be formed. The finding appears even more surprising in view of the fact that the interview process itself could be expected to lead the participants to make these mental links. This hypothesis could be tested by conducting the interview with two groups of children: half (the control group) to be given the interview as in the present study and the other half (the experimental group) to be given in addition some training in making the necessary mental connections.

That some of the children were able to make a conceptual link relating to one item of knowledge was illustrated in their response to questioning about appropriate food for hens. Six of them explained that they knew this “*because hens are like birds*”, illustrating a mental link between their experiences of feeding wild and pet birds on bread, seeds and nuts and their categorisation of hens as birds. Unlike an appreciation of human dependence upon plants for food, however, this idea is much less complex.

Another possible explanation can be made from a post-Piagetian perspective. In this case the demonstration of understanding depends upon the formation of an organising biological theory of ‘life’. Further work, similar to that reviewed in chapter three, of Slaughter, Jakkola and Carey (1999), is required to test the idea that a theory of biology is the key. Correlation would be sought between those children who hold a theory of life which incorporates plants as food producers, and those who demonstrate understanding of the ultimate human dependence upon plants for all their food.

6.4.3 Intriguing responses

There are two types of response given by the younger children which require explanation:

a) Misleading indications of knowledge limitation

Eight children stated that they know only that eggs come from shops or factories even when it is later found they also know that hens lay eggs. There is a similar finding for the origin of lettuce and tomatoes: in response to the pictures of these items children said that they came from shops or factories when later in the same interview it transpires that they knew these items are grown.

b) Statements that would be surprising if given by an adult

It would be surprising if an adult suggested that eggs or chicken are suitable foods for hens, that milk or beef are suitable foods for cows, that cows produce eggs and that mice are used for making cheese.

These unexpected responses cannot be classified as misconceptions which will interfere with future learning, since they are not given by older children. It is therefore necessary to consider developmental explanations for these findings. Several are possible:

- i) knowledge limitation,
- ii) interpretation of context cues,
- iii) categorisation,
- iv) enculturation,
- v) linguistic comprehension,
- vi) processing limitations (working memory),
- vii) limitations of executive control,
- viii) connectionist theory,
- ix) restructuring of children's ideas.

These are now discussed in turn.

i) Knowledge limitation

The simple statement that they did not know was given more frequently in response to a question by the youngest children rather than the older ones in this study. Also, as found in the discourse analysis of children's response to the interviews, thirteen of the four-year-old children responded in a way which was not relevant to the question. This was the case with only two of the six-year-olds and none of the eight-year-olds. These responses may simply indicate a lack of knowledge on the part of the respondents.

However, other statements given by the younger children in this study give a misleading impression of knowledge limitation. Although the statements that eggs, milk, tomatoes and lettuce come from shops are correct, they do not ascribe an organic origin for these items. Indeed, the photographs of eggs and of milk show the supermarket cartons in which these items were packaged for sale and so may have encouraged a commercial response. But when children were probed further by being asked, "Where do the shops get the eggs from?" or "where do the shops get the lettuce (or tomatoes) from?" they could say only that "*A man brings them,*" or they come "*from factories*". Explanations such as these appear to indicate a lack of knowledge that hens lay eggs or that lettuce and tomatoes are grown.

This type of finding is not unusual in young children. When working with a class of five- to six-year-old children, Norman (2000) asked them where they thought fruit and vegetables came from. She found that "*bags*" and "*factories*" were amongst the most common suggestions. One child, when asked to explain his answer of "*the shops*", said that fruit was made in the back of the supermarket like the bread. Norman took these statements at face value saying, "I was intrigued to think that

children from a rural school, who have fruit as a break-time snack, did not really know what they were eating!" (Norman, 2000: 6-7).

When interpreting these statements, the very fact that children gave further details when asked, "Where do the shops get them from?" led the questioner to assume that this type of response was an indication of a coherent body of the child's knowledge. However, in the present study children had a second opportunity to state the origin of eggs, tomatoes and lettuce. In this case many of the same children who could not give an organic origin for eggs when shown a photograph of them stated that hens do lay eggs when shown the photograph of hens. In a similar way, some of the younger children who stated that tomatoes and lettuce came from shops were able to say, later in the interview, that they had seen tomatoes and lettuce growing in someone's garden. The conclusion to be drawn from these findings is that young children sometimes give an incorrect indication of the limitation of their knowledge.

ii) Interpretation of context cues

A possible explanation for young children's incorrect indication of their knowledge is that the questioning was misinterpreted by the younger children: either the photograph or the wording of the question was misleading.

However, as explained in chapter five, the photographs were expressly chosen to have ecological validity. As well as this, similar findings obtained by Norman (2000), using almost identical vocabulary and sentence structure, were procured without the use of photographs. A further point is that in chapter nine a tape-recorded home cooking session illustrates exactly the same form of question and response taking place between a mother and her child.

This evidence indicates that the cues themselves are regarded as appropriate by those dealing with young children. Instead it seems that different context cues elicit different aspects of a young child's knowledge. Further interviews could be devised to test this hypothesis.

iii) Categorisation

Given that there are two possible ways of responding to questions about the origin of eggs, lettuce and tomatoes, the following question must be asked: Why should younger children often choose a commercial response (such as shops and factories) whereas the older children choose an organic one (that they are grown)?

Developmental changes in categorisation could account for this. As explained in chapter three, Rosch and her colleagues (1976) found that whereas children older than seven years of age sort objects on the basis of the taxonomic category of an object, younger children often sort objects on the basis of causal or temporal relations. In the present study there is a thematic relation between shops on the one hand and eggs, tomatoes and lettuce on the other because children go to the shops to buy these items. So the younger children might have been inclined to choose this type of categorisation.

However, Rosch and her colleagues argue that younger children are capable of sorting on the basis of taxonomic category if helped to do so. Therefore further interviews, which include a short training sequence in the use of taxonomic categories, are needed in order to test the hypothesis that this interpretation of children's responses is correct.

iv) Enculturation

It was suggested in chapter three that the use of taxonomic categories is an example of Western culture. It seems likely that children learn this aspect of Western culture during their early years at school, enabling them to anticipate the type of response expected. Thus children who have more experience of schooling will realise that the use of taxonomic categories is important when deciding how to respond to a question. Studies of children from different cultures would be necessary to test this hypothesis.

v) Linguistic comprehension

Two researchers, whose work is mentioned in the first part of this thesis, refer to linguistic interpretation when conducting interviews with children. Although (as explained earlier in this thesis) Johnson (1997: 151), a developmentalist, reassures workers that "at around four years of age most normal children have acquired the basic morphological and syntactic structures of their native language", Johnson (1996), a science educator, notes that there are two points at which linguistic misinterpretation may occur: both in the child and in the questioner.

Two examples of the intriguing statements of younger children can be analysed in order to explore this problem of linguistic comprehension. These are that cows feed upon milk and that hens feed upon eggs.

In the first example, three children who at first appeared to believe that milk is fed to adult cows were later shown to be thinking of calves (as described earlier in this chapter). On the other hand, two other children clearly stated that the adult cow shown in the photograph, and whose udder they identified as producing the milk, actually drinks it. As explained above, one boy, Gavin, stated that the cow would be able to reach back to its own udder by running. Unfortunately, one four-year-old child so surprised the researcher by stating that the cow shown in the photograph would drink milk that she was unable to fulfil her own intention: instead of reacting in a neutral way to the response she explained to the child that only calves drink milk. Thus she denied herself the opportunity for further questioning in order to clarify exactly what the child had in mind.

In the second example, ten children stated that hens might be given eggs for food. There was a clear decline in the number of children giving this response from the younger to the older children. Six four-year-olds, three six-year-olds and one eight-year-old child said this. Only one four-year-old child gave a reason for his response, saying that it was because "*hens lay eggs*", thus indicating only a mental connection between hens and eggs.

The data can be explored for three further possible interpretations of this intriguing result. Firstly, it might be an example of anthropomorphism. Having first looked at a picture of eggs being cooked in a frying pan for human food, the children might think that hens are like humans who like to eat eggs. However, one child who mentioned eggs as food for hens also mentioned seeds, another mentioned grass and a third worms. Therefore, it would seem that in those cases, at least, the children were not thinking that hens consume a typical human diet.

The second interpretation acknowledges that in times past when hens were raised on a small scale it was customary for egg shells to be ground up and added to their feed as a source of calcium. However, there is no reason to believe that the children questioned knew this. Indeed, those children who claimed to have fed hens themselves mentioned only bread, corn, seeds and grain as suitable food for them.

The third interpretation for the statement that hens feed upon eggs is that the children were thinking of a chick developing inside the egg, using the yolk as a source of nutrients. If this were the case, it would be expected that the statement would be more common among the older children (whereas in fact the opposite is the case), since it depends upon knowledge of a process that cannot be seen directly. One four-year-old definitely did not have this in mind, as he explained that hens eat

"eggs that don't hatch". The likelihood that the other children were thinking of developing chicks requires further examination of the data. There was a difference in the learning experiences available to children in the two localities studied (as described in chapter nine). Each year the staff of the nursery at Sea View incubated some eggs in their open-plan classroom. They explained what was happening to the eggs and allowed the children to see the newly hatched chicks. This experience was not offered to the pupils at Manor House nursery, who instead discussed pictures and viewed a video film of eggs and chicks at Easter time. Therefore, it is to be expected that if the four-year-old children knew about developing chicks feeding upon the yolk, they would have attended Sea View rather than Manor House nursery. That was not the case. Only one of the six four-year-old children who stated that hens eat eggs attended Sea View nursery. In fact, even at Sea View nursery the pupils did not seem to be very knowledgeable about the events taking place inside the eggs during incubation, as can be seen in the following extracts from interviews with Sea View nursery pupils.

When four-year-old Liam was asked where the baby hens come from he said:

70. L. Out of the eggs.

71. R. Out of the eggs, right. You've got some little chicks, baby chicks in the nursery, haven't you? Ah, right. What do you have to do to help the chicks come out?

72. L. Hatch.

73. R. To help them hatch. What do you have to do to help them hatch?

74. L. Put them in an incubator.

75. R. Oh, right. You put them in an incubator. And what happens then?

76. L. Then they hatch.

Alexandra was asked what can happen to eggs that are not eaten [by humans] and replied:

38. A. Turn into chicks.

39. R. Turn into little chicks. And you've got some little chicks in the nursery, haven't you? That's right. What do you have to do to help the eggs turn into little chicks?

40. A. The, ... the hens sit on them and make them crack.

Lee was asked whether he knew what has to be done to make the eggs turn into baby chickens and said:

130. L. Wait till they crack.

131. R. You have to wait till they crack. What do you have to do, though, to get to help them to get ready to crack?

132. L. Need to sit on them for days and days and days.

133. R. The chickens would have to sit on them for days and days and days? I didn't see anyone in the nursery sitting on them, though.

When asked how the eggs were kept warm, he replied:

- 140. L. In the egg thing.
- 141. R. You can't remember the name of the thing that you put them in?
- 142. L. No.
- 143. R. Wasn't it in an incubator?
- 144. L. Yes.

Victoria explained that some eggs have got baby chicks in them and was asked:

- 27. R. You've got some little chicks in your room, haven't you?
- 28. V. Yeah.
- 29. R. Oh, that's lovely. What did you have to do to help the chicks come out of the eggs?
- 30. V. They have to get warm. They crack all by theirself.

When four-year-old Sarah was asked the same question she could only say, "*You have to sit on them to keep them warm*".

By the time the six-year-old children were interviewed the researcher had recovered her surprise well enough to probe further. After Ellys had mentioned that hens eat worms, the following exchange took place:

- 97. R. Does the farmer give them anything else?
- 98. E. He gives them eggs as well.
- 99. R. I thought they laid the eggs?
- 100. E. They might be able to eat some.

Thus it can be seen that six-year-old Ellys did indeed mean that adult hens could be given eggs to eat but that she reconsidered this idea when questioned further.

More pupils at Sea View mentioned incubation of eggs when talking about the possible appearance of baby chicks than did Manor House pupils, but that fact seemed to be the limit of their knowledge. This is not surprising, as it accords with Russell and Watt (1990), whose work on children's ideas about growth is reviewed in the first part of this thesis. In their initial exploration of children's ideas they found so little response to questions about the process of development inside incubating eggs in children below the age of ten years that they abandoned questions on this process from their main study.

Overall, then, it would appear that some of the children at least did have in mind that adult animals could be fed upon the very products they are reared to supply. On being challenged, some attempted to justify this claim (for example, Gavin's description of the cow running to reach it's own udder) whereas others were prepared to retract their statements.

If some of these younger children really did have more knowledge of obscure facts than older children that really *would* be surprising!

Further interviews are needed in order to probe in depth how strongly children hold ideas such as these and the reasons they are prepared to give to support them. However, since only a minority of children in the sample gave these intriguing responses, it is likely to be very time-consuming process.

vi) Processing (working memory) limitations

As explained in chapter three, a number of factors, including general immaturities of the nervous system, result in young children being able to hold fewer items in working memory than is the case for older subjects. This immaturity limits their ability to reason about several items at once. Therefore it offers a possible explanation for the finding that young children cannot mention both shops and hens in response to a single picture cue. Although this limitation of working memory in young children is well known, the knowledge of it has not before been applied to the analysis of their responses in the work reviewed in chapters three and four. It would be interesting to study this phenomenon further through interviews designed to test this hypothesis.

vii) Limitations of executive control

As explained in chapter three, although the frontal cortex of the brain shows evidence of some functioning in early childhood, it does not reach maturity until the teenage years. This is the area of the brain responsible for planning and monitoring cognitive activity. An example cited in Diamond's (1991) work with infants suggests that because of this, very young subjects are unable to inhibit a predominant action tendency. Once they have begun one mental action they find it difficult to switch to another, even when they know very well how to enact it. It is explained in chapter three that limitations in cognitive control are still detectable (although to a lesser extent) in older children. Although this work has not yet been applied to research in the domain of science, it indicates another explanation of why, once having begun to talk about items being bought from shops, young children find it difficult to switch to talk about their organic origin. More work is needed in the area of developmental cognitive neuroscience in order to confirm this explanation.

viii) Connectionist theory

The intriguing statements of young children which have been discussed so far appear to be the outcome of sensible reasoning. However, a few of the statements appear to be less sensible: that chicken is a suitable food for hens, that beef is a suitable food for cows and that cows produce eggs. One is quite bizarre: that mice are used for making cheese. Another intriguing statement, made by a four-year-old child, is that eggs come from "*cluck, cluck*".

The fascinating aspect of these responses is that it is possible to make mental links among these items. Just as there is a connection between hens and eggs, and between cows and milk (as discussed above), so there is a connection between cows and eggs, between mice and cheese and between the words *cluck, cluck* and eggs. However, these links do not provide appropriate answers to the questions put to the children. Few of these intriguing statements were made by six-year-olds and none were made by eight-year-old children.

Four-year-old Sarah was able to explain her reasoning for stating that eggs come from cows in this way:

25. R. Cows, right. What makes you say that?

26. S. Because, because you get milk from cows and milk is like eggs.

In this interview, Sarah has probably made a mental link connecting milk and eggs because both together are commercially delivered to her doorstep on a regular basis. On the other hand, it is likely that the child who responded to the question of where eggs come from with the words, *cluck, cluck*, was actually thinking of hens even though her response was inappropriate, since *cluck, cluck* is the sound hens make when they lay their eggs.

An appropriate link between the words *mice* and *cheese* was made by two children, who said that cheese is a food enjoyed by mice. Therefore it seems likely that the third child who responded with the word, *mice*, when asked the ingredients of cheese, had made a similar mental link between mice and cheese as the first two children but had not evaluated its appropriateness for a response to the question.

Several children were able to make an appropriate mental link between chicken meat and hens, and between beef and cows, when asked about the origin of meat. However, the children who identified chicken meat as food for chickens and beef as food for cows, made a less appropriate mental link.

Stevenson's (1993) model of memory as a distributed network contributes to an explanation for these inappropriate mental links. She suggests that at first each unit of information about a topic is linked by mutually excitatory connections to all other related units. When a subject is required to recall an item from memory, the trigger will activate units with which it has these links. However, some of the links may be inappropriate and could lead to an erroneous response. In older subjects, productive links will have been strengthened by usage while others remain weak. Since young children have not yet had the required number of learning experiences to strengthen productive links their ability to inhibit inappropriate ones is not yet well developed. Claxton (1997), too, writes of the effects of strengthened pathways within the brain.

If this explanation is correct, it should be possible to help children to develop useful mental connections through appropriate teaching, something which could be tested through experimentation with the use of two different teaching approaches with matched groups of children.

ix) Restructuring of ideas or theories

As described in chapter three, the explanation put forward by developmental psychologists for some of the intriguing responses given by young children is that the underlying theories they hold in understanding the world are different in kind from those held by older respondents. In this view, it is to be expected that children will employ such theories both in the interpretation of questions put to them and also in the formulation of their responses. However, no such underlying theory has been identified as likely to be responsible for the intriguing responses found in the present study.

6.4.4 Responses which could indicate the basis of misconceptions

It seems reasonable to believe that a simple lack of information is the explanation for the incomplete responses given by young children. For example, if few of them could say that air and light is necessary for the growth of plants then the explanation would be that they have not yet had the opportunity to learn this. After all, it is only in the middle years of secondary schooling that they will be introduced to the process of photosynthesis. However, findings reported in the literature indicate that many children do *not* easily assimilate the idea of photosynthesis in later years. In fact, Leach and his colleagues (1992) discovered that a large proportion of sixteen-year-old pupils did not believe that the main solid constituent of plant material comes from carbon dioxide in the air or that sunlight provides the energy required to

convert this gas into sugar. Furthermore, this was the case even after they had been taught about the process. Instead, these pupils sustained a misconception that all the material necessary for the growth of plants comes from the soil in the form of water and minerals.

Why does this misconception persist? One reason for their emphasis on the importance of water is that learners will have had very many opportunities, both at school and elsewhere, to water plants. They will have been able to observe the recovery of a wilting plant shortly afterwards, so that a connection can be made. In addition, many will have noted that minerals are sometimes added to the water from a container labelled 'plant food'. In fact, both of these observations are recorded in the empirical data recorded in part three of this study.

At the same time, it is not surprising that most young children do not mention carbon dioxide or air as necessary for growing plants as it cannot be seen. Nor is it surprising that warmth but not light from the sun is mentioned as necessary for plants. Children do not realise that sunshine provides light energy for food production and thence growth, since humans themselves do not take part in this process. In reality, children make use of light only to facilitate the sense of sight.

If it were simply a matter of slotting information into gaps that were waiting to be filled in children's knowledge structure they would not find photosynthesis so counterintuitive. Instead, the constructivist view is that children already have a coherent view of plant growth in which there are no gaps. Air and light are not included in this view.

The constructivist literature makes no distinction between information gathered through focused attention on one hand and tacit knowledge gained unintentionally by the process of implicit learning on the other. However, it is the latter type of learning which, according to Squire and Zola (1996), can lead to a sense of intuition which, although it may not be clearly articulated, is nevertheless very robust. In relation to photosynthesis it means that pupils may arrive at lessons with information gained implicitly through many sensory experiences in early childhood but never put into words. It is this knowledge which may be in conflict with the formal statements made in science classrooms about photosynthesis.

If this is the case, then according to Karmiloff-Smith's model of Representational Redescription (outlined in chapter two), it should be possible to help young children to make their implicit knowledge explicit and to think about it in new ways in

preparation for an understanding of photosynthesis. However, as she describes the process as taking place over time (as an aspect of development) and commonly endogenous, a lengthy longitudinal study might be required in order to test this hypothesis.

6.4.5 The relevance of children's responses

A large number of irrelevant responses were identified among the younger children. Indeed, as reported in section 6.3.5, twelve four-year-old children made one or more responses which appeared to have no connection at all with the subject of the researcher's question. As most of these irrelevant responses were of a personal nature, it would seem that they indicate a wish, on the part of the children, to make a closer or perhaps more comfortable connection with the researcher than simply the impersonal response to questions of the researcher's choosing.

According to Siegal's (1991) analysis of the difficulties of working with young children outlined in the first part of the thesis these responses can be seen as the product of the differential power relationship between an adult and a young child, with the willingness to please an adult on the one hand and determination to fulfil one's own agenda on the other.

Other developmental explanations might include a differential ability to stay on task, to interpret the questions, to apply categorisation, and to cope with the limitations of working memory. All of these have been mentioned in the discussion of children's intriguing responses.

6.5. Conclusion

The findings reported in this chapter illustrate considerable knowledge of factual items which contribute to an understanding of the organic origin of food in even the youngest children. They also indicate an increase of knowledge with age. However, only by age eight did many of them demonstrate understanding of human dependence upon plants for the provision of life-supporting food, an achievement which was not directly related to knowledge of relevant facts. Neither gender nor socio-economic status appear to have affected the development of children's knowledge and understanding of these items.

Children aged four years, in particular, responded to questioning with answers that would be surprising if given by an adult. Categorisation of these answers indicates

that there are several different reasons for them. Despite this, the types of response were not a good match with the five mentioned by Piaget (1929). To some extent this is to be expected as the questions in this study were factual whereas Piaget's were designed to discover children's reasoning. However, an important aspect of the present study is the possibility of a number of developmental interpretations which were not available to Piaget. These interpretations have not been found to date in the literature concerning children's developing ideas in biology. Therefore many suggestions have been made for further work.

One finding is of particular relevance to science educators. It is that a combination of intriguing and irrelevant responses by the youngest children serves to obscure the fact that they exhibit the foundation for a scientific misconception about the conditions plants require for growth. This could interfere with future learning about photosynthesis.

PART THREE: THE EMPIRICAL ENQUIRY INTO THE SOURCES OF CHILDREN'S KNOWLEDGE

CHAPTER SEVEN

REVIEW OF LITERATURE RELATING TO LEARNING OPPORTUNITIES OUTSIDE SCHOOL

7.1 Introduction

The third part of the thesis is concerned with the sources of children's knowledge, paying particular attention to informal opportunities for learning. It is based on the notion, explained in chapter two, that children construct their knowledge by building upon what they know already and that understanding comes about by the formation of meaningful mental links among knowledge items. It is suggested in this thesis that educators need to know something of the origin of children's knowledge. Then they will be better able to help learners bring that knowledge to mind and relate it to the new material taught in class, as Stevenson and Palmer (1994) advise.

The authors whose work is reviewed in part one of the thesis suggest that factual knowledge originates through both sensory experiences and cultural mediation. Thus, when sensory experiences are frequent and easily available, relevant knowledge will follow (for example, Gellert, 1962). On the other hand, when perceptions are less accessible or ambiguous, knowledge will be slow to develop (for example, Osborne, Wadsworth and Black, 1992). The media, such as television and magazines, together with personal interaction are regarded as secondary sources of children's accurate knowledge (for example, Hatano and his associates, 1993); although they are also blamed for inaccurate ideas (for example, Osborne, Wadsworth and Black, 1992).

In Driver's (1983) account of scientific misconceptions (described in chapter two), she explains that children's early experiences can give rise to alternative views which in turn can have a detrimental effect on school learning. She suggests that misconceptions originate through both direct experience and secondary sources such as conversations and the media. However, Driver emphasises the role of information available to children in informal settings.

The belief that learning in science does not occur uniquely in school settings is confirmed by Lucas, who notes that “there are now sufficient anecdotes and personal experiences to convince us that connections are made between accidentally encountered ideas, objects and events [and scientific ideas]” (Lucas, 1993: 143). This comes as no surprise to those who work with young children, since they emphasise the influence of the home environment on children’s learning and development. For example, Dierking and Falk (1994: 63) note that “a major function of the family is to support learning among its members”.

Notwithstanding this acknowledgement of its importance, the authors whose work is reviewed in the first part of this thesis do not tease out details of the informal sources of children’s knowledge and provide no empirical evidence in support of their suggestions. In fact it is only more recently that Gray (1998: 34) notes that “the influence of family backgrounds on children’s development has long been recognised”, making a plea for research into children’s home experiences.

One reason for this lacuna in knowledge is that the desire to research learning in informal settings poses the problem of access to relevant data. For example, “How can one systematically study science learning that takes place over the dinner table?” asks Lucas (1993: 146), who suggests that a rich supply of well documented anecdote is lacking. Therefore, in contrast to the difficulties of research in domestic settings, where the occurrence of relevant conversations cannot be predicted, he notes that it is much easier to record family interactions during museum visits. Here, there is a clear intention to instruct and it is at least reasonable to expect that people come with the intention of ‘learning’ something.

Such is the paucity of material regarding informal learning opportunities for young children that it has been necessary in this chapter to make reference to research in domains other than science. Studies of home-based opportunities for young children to learn in mathematics, language and through cognitive stimulation are included as well, since both the findings and methods employed can inform the empirical work in this part of the thesis.

Studies of learning in informal settings do not always employ data collected through direct observations of the researcher. Much is reported by parents and children. This raises the question as to what extent such data, especially those provided by young children, can be regarded as an accurate record of events. In an attempt to address this question of reliability a section on autobiographical memory is included in this chapter.

The aim of the chapter is thus twofold. Firstly, it is to identify aspects relevant to this thesis of what is already known about learning outside school. Secondly, it is to evaluate the methods employed in order to inform the present study.

7.2 Outline

After examining the findings reported in the literature relating to learning outside school, the methods involved are evaluated. A discussion of the reliability of autobiographical memory forms the third section of the review. In conclusion, there is a summary of points most relevant to this part of the thesis.

7.3. Opportunities for learning outside school

Research findings relevant to the thesis are reviewed in this section. These relate to opportunities for learning outside school, firstly in science and then in the home environment through cognitive stimulation and language.

a) Opportunities for science learning

Apart from Solomon's (1994b) home/school project and Mayall's (1994) work with primary school pupils, studies of children's opportunities to learn about science have been restricted to those settings which have an educational purpose: museums, science exploratories and zoos.

Table 7.1 Opportunities for science learning outside school

Author(s)	Year	Location	Subjects	Design	Topic
Tunnicliffe et al.	1997	South Kensington & London Zoo	Primary school pupils & caregivers	Cross-sectional	Animals at museum & zoo
Brooke and Solomon	1996, 1998	Bucks.	Primary school pupils	Cross-sectional	Vista science activities
Solomon	1994b	Oxford	Primary school pupils	Cross-sectional	Home/school science
Mayall	1994	London	Primary school pupils	Cross-sectional	Health education

In all, only four published studies involving young children have been found for the focus of this section. These are summarised in table 7.1.

Further information is provided by Dierking and Falk (1994), who reviewed a number of unpublished Ph.D. theses as well as several reports produced by museums in the United States. Their work is noted as a secondary source.

Dierking and Falk (1994) identify the role of prior knowledge as an important variable in the promotion of learning at museums. They note that families assist children in making mental connections by discussing the exhibits in terms of the child's prior knowledge and experience. The prior knowledge of the accompanying adults is important too, so that: "people who enter an exhibition gallery with more science knowledge tend to learn more than those with less prerequisite knowledge" argue Dierking and Falk (1994: 63).

The importance of making connections with prior knowledge is also emphasised by Tunnicliffe and her colleagues (1997). They found that young visitors at the Science Museum in South Kensington and at London Zoo, be they pupils on a school visit or with their family, made interpretations of the exhibits based upon their prior knowledge.

Tunnicliffe and her colleagues were surprised to find many similarities between school and family groups in the content of their conversations. They appeared to be predominantly both socially and information oriented, irrespective of the rationale for making the visit. Despite these similarities, however, there were differences: "the higher management and social component of conversations in family groups was striking" note Tunnicliffe, Lucas and Osborne (1997: 1048). They believe that whereas school groups focus on the exhibit, leisure visitors emphasise social bonding which involves control.

The Vale Interactive Science and Technology Adventure (Vista) facility enabled primary school pupils to engage in open-ended fun activities linked to National Curriculum science themes. Here, Brooke and Solomon concluded that "when speculations, however simple, about cause and effect are entertained a more active curiosity may flourish which leads on towards investigation" (Brooke and Solomon, 1998: 969).

On the assumption that children would benefit from parental involvement, Solomon (1994b) devised a series of simple science investigations relating to school work but

which could be carried out at home. Transcripts of recordings made during the home science activities revealed a collection of behaviours: teaching, encouraging, collaborating and facilitating sequences were interspersed with jokes, concern with cleanliness and furnishings, references to baby-care, and attitudes to home maintenance.

According to Mayall (1994), who investigated attitudes to health, their home is where children's first learning takes place and it remains the most important influence on their ideas.

b) Opportunities for learning at home: cognitive stimulation and language

Research into opportunities for young children to learn at home, relating to cognitive stimulation and language, provide information relevant to this thesis. For example, it was noted in the first part of the thesis that socio/cultural factors appear to influence learning in science. Table 7.2 provides a summary of the three studies reviewed.

Table 7.2 Opportunities for learning at home: cognitive stimulation and language

Author(s)	Year	Location	Subjects	Design	Topic
Bradley et al.	1989	USA	Early childhood	Longitudinal	Cognitive stimulation
Flewitt	2002	UK	Pre-school	Longitudinal	Language development
Tizard & Hughes	1984	London, UK	Pre-school	Single age	Language development

With regard to those aspects of the home environment which stimulate cognitive development, Bradley and his colleagues (1989) found that parental responsiveness and the availability of stimulating play materials were more strongly related to progress than global measures of environmental quality such as socio-economic status.

Flewitt (2002) made a detailed study of six three-year-old children's language during their year at a pre-school playgroup. She was able to record differences in gesture as well as verbal exchange between playgroup and home. There were very different adult perceptions of these young children in the two settings. For example,

one child chatted constantly at home but rarely spoke at playgroup, relying instead upon gestures as her means of communication.

In response to the suggestion that opportunities for language development in the home was an important variable in children's academic achievement at school, Tizard and Hughes (1984) examined the difference between conversational exchange at home and at nursery school in young children. One of the strongest impressions gained from this study was the amount children learned simply by being with their mothers: "discussing what each was doing, or had done, what they would do next, arguing with each other, and, above all, asking questions" (Tizard and Hughes, 1984: 72).

Tizard and Hughes (1984) provide an example of the process of scaffolding (described in chapter two): that of discussing jointly experienced past and future events. They observed that "the mother helps the child express her meaning and follow through some of the implications of what she is saying ... thus enabling a shared world of common experience to act as a backcloth to their conversations" (Tizard and Hughes, 1984: 83). Of particular relevance to this thesis are the comments of Tizard and Hughes about the special attributes of learning at home which appeared to be unknown by nursery staff. They found that talk occurred in a wide variety of contexts and that "the most intellectually challenging conversations tended to occur at mealtimes, or when mother and child were doing nothing in particular, or when the child was watching her mother at work" (Tizard and Hughes, 1984: 98). They also discovered that by and large, parents were willing to consider their children's wishes in plans for family activities. Workers in the nursery, on the other hand, had little idea of pupils' learning experiences outside the classroom and failed to capitalise upon them when working with children.

7.4 The methodologies employed

In addition to the work discussed so far, three further studies of children's learning at home employ methodologies which can inform this part of the thesis. They are summarised in table 7.3. The studies illustrate a number of designs and methods of data collection, which are discussed in terms of validity and reliability.

Table 7.3 Opportunities for learning language and mathematics at home and the development of attitudes to learning

Authors	Year	Location	Subjects	Design	Topic
Merttens & Woods	1994	Inner London	Primary school pupils	Cross-sectional	Home/school mathematics
Pollard & Filer	1996	English home counties	Primary school pupils	Longitudinal	Attitudes to learning
Wells	1980	Exeter	Babies & pre-school	Longitudinal	Language development

Research design

Taken as a whole it can be seen that whereas the studies reviewed in the first part of this thesis were cross-sectional, the design of four of the studies reviewed in this chapter were longitudinal. The work of Bradley and his colleagues (1989), Wells (1980) and Pollard and Filer (1996) all took place with the same subjects over several years and Flewitt's (2002) over several months.

Sampling

The sociological concept of random sampling is impractical in many types of educational research. Thus "most educational research is a complex combination of the variants of criterion-based selection and probabilistic sampling," explain Goetz and LeCompte (1984: 83). They suggest that the choice of sampling strategies depends upon the goals and questions formulated by a researcher, the nature of the empirical or real-world unit that is to be studied, overall theoretical and conceptual frameworks informing the study, and the credibility intended by the researcher in generalising or comparing obtained results. The studies reviewed in this chapter illustrate this. In no case was it possible to choose a random sample of participants from the general population. In some cases, for example the visitors at the museum and zoo, the participants themselves made the choice by deciding to make the visit and on arrival were asked permission for their conversations to be recorded and analysed by the researchers. In other cases, the individuals were connected with the researchers by virtue of some professional link and were then selected in some informal way. For example, a large number of families took part in the home/school projects (Solomon, 1994; Merttens, 1994), but only a few were visited at home by

the researchers. The families visited were either volunteers or had been suggested by teachers by reason of their co-operation in previous ventures.

Strategies for data collection

Several different strategies were employed in the search for accounts of children's experiences in informal settings. At one extreme, Bradley and his colleagues (1989) used a single instrument, an inventory, in their assessment of cognitive stimulation within the home. At the other extreme, Mayall (1994) and Pollard and Filer (1996) collected data from several sources: from pupils, teachers and parents as well as from their own observations. Mертens and Woods (1994) and Solomon (1994b) relied heavily upon self-reporting on the part of parents for events that took place at home, whereas Brooke and Solomon (1996; 1998) obtained data from the children themselves as well as through personal observation. Records in the form of a booklet, which had defined spaces for the recording of each item were kept by parents in Solomon's (1994b) and Mертens and Woods' (1994) home/school projects.

Conversations were most often captured in the form of tape-recordings which were transcribed later (for example, Tizard and Hughes, 1984; Wells, 1980). Flewitt (2002) utilized video recordings in order to apprehend gestures as well.

Reliability and validity

Bradley and his colleagues (1989) claim high reliability for their inventories against national norms. On the other hand, Mayall (1994) and Pollard and Filer (1996) together with Wells (1980), claim high ecological validity for their rich ethnographic data.

What reassurance is there that the conversations recorded were in any way typical? As Hammersley and Atkinson (1995) argue, research in a naturalistic setting is no guarantee of validity. For example, the presence and activities of the observer may in themselves influence the participants and so produce data which are not typical in the absence of a researcher. Furthermore, the conclusions drawn may be invalid because the data collected at one time in the cycle of the setting may not reflect occurrences that take place at other times. This is especially so for young children in educational settings because each part of the school year has special characteristics. At the beginning they must settle into a new school or class and at the end take part in transfer arrangements. During the year their activities reflect the seasons, so that in autumn they engage in activities relating to festivals such as Christmas whereas in the summer they take part in out-of-school visits.

Even though Wells (1980) regards the sampling of home conversations by means of a timer as the greatest strength of his data collection, he also identifies it as the most serious limitation of his research strategy. This is because although the material recorded is 'real life' behaviour of the subjects, it is still the case that "the data are liable to be unrepresentative in other ways, as a result of the biases introduced by a whole host of situational variables which are inadequately understood and impossible to control" (Wells, 1980: 126).

Tizard and Hughes (1984), on the other hand, simply recorded conversations at the nursery during morning sessions and when the children were at home in the afternoons. In common with most other researchers concerned with collecting data in naturalistic settings, they employed familiarisation in order to reduce participants' awareness of the recording procedure. Therefore the first two recordings were discarded. It was assumed that the third set of conversations, which were analysed for use in the study, were representative of normal exchanges.

Pollard and Filer (1996: xii) claim that their research provides an account of "detailed, wide-ranging and sustained case-study work" with seven children over several years. They began with classroom observations. Then pupils were interviewed in groups and individually, and examples of their work were collected. The parents of the seven children were asked to keep diaries on two occasions each year. The first annual entry recorded routine family events over a weekend. The other entry provided an overview of the year as a whole, considering the child's learning progress, his or her social, emotional and physical development and key social relationships and experiences. Interviews, in the form of discussion, were employed to follow up each diary entry.

According to Hammersley and Atkinson (1995), an imbalance of social location between researcher and subject might be a cause of influence or bias. In order to overcome this, Coffield (1980) argues that ethnographic research should be seen as an act of negotiation between researcher and participant. As explained in the second part of this thesis, in the case of educational settings the researcher negotiated with the Local Education Authority, teachers and parents as well as with pupils. Moreover, the difference in power between an adult researcher and young children is particularly salient.

In acknowledgement of these limitations, a reflexive approach is recognised as an important component of ethnographic studies. For example, Mayall (1994) explains

that she asked older pupils about their memories of reception class experiences in order to match their statements with those of current reception class pupils.

7.5 Autobiographical memory research

It might be thought at first that parental reports in the form of diaries and questionnaires can be valued only as data at second-hand. However, they are concerned with children's experiences in the context of home and family. Therefore the parents themselves take part in the events concerning their children which they describe. The diaries and questionnaires they submit are in fact records of their own experiences which they have shared in some way with their children. Thus it is relevant to consider the nature of autobiographical memory in connection with data gathered from parents as well as from the children.

In this section the general literature relating to autobiographical memory is the first to be reviewed. Then there is a discussion of the particular issues relating to the elicitation of memories in young children.

The point to make is that autobiographical memory is not a collection of accurate facts which can be drawn upon at will. Items are stored or forgotten, interpreted or even altered, in the process of memory making.

Memory creation

Personal experiences are encoded and stored by selective processes. Some of these processes take place with deliberation and awareness but others do not. In agreement with the account of the processing of sensory data provided in chapter two, Conway (1996: 87) explains that the encoding of autobiographical memories is a complex process, influenced by "the personal interpretation developed during an experience, changes in attention, and the integration of event knowledge with structures in the autobiographical knowledge base". This idea of discrimination in the construction of personal memory is reiterated by Robinson (1996: 199), who notes that "an essential premise of cognitive psychology is that people selectively process the information available to them in their world".

Categorisation of memories

According to Conway (1990), the manner in which autobiographical information is categorised influences the nature of memories, which are organised in a nested hierarchy. "At the top level ... are abstract representations of lifetime periods containing knowledge about personally relevant goals and life themes. At the bottom level are autobiographical memories of specific events" (Conway, 1990: 129).

Robinson notes that this categorisation process can give rise to inaccuracies: "Because we categorise situations and events according to features abstracted and generalised from experience, we may overlook or misinterpret information when a familiar pattern can be easily read into a situation" (Robinson, 1996: 199). Furthermore, it seems that certain details may be added in the act of recollection. For example, "location and temporal information may not be specifically represented as part of a memory but inferred in some way" (Conway, 1990: 12).

Because it is important that the possibility of chaos and confusion in memory is kept at bay, processing imposes a coherence that derives from the distinctive organisation of knowledge and feeling that characterises each person. "Thus, experiencing is inevitably an expression of a perspective or point of view" (Robinson 1996: 199).

The selectivity of retrieval

The very act of memory retrieval offers a further opportunity for selectivity because it is highly task dependent and cue sensitive. "Different tasks will lead to the sampling of different sets of memories" (Conway, 1990: 60).

Forgetting, or the absence of memories

Some personal experiences may be completely forgotten. Conway (1996: 87) argues that "events that do not impinge upon current themes, plans, and goals of the self, and that do not correspond to existing autobiographical knowledge structures, may simply not be encoded in long-term memory".

The reorganisation and change of memories

It is clear from the above account that the nature of autobiographical memory is closely related to the fashioning of personal meaning. Robinson (1996: 201) explains that "the development of meaning has two routes: categorisation and recategorisation, and by elaboration". For example, it seems that sometimes an aspect of experience that was barely noticed at the time may become salient later on. As well as this, "new information or altered perspective can prompt us to reinterpret specific experiences or entire segments of our personal history" (Robinson, 1996: 202). This idea is developed by Barclay (1996), who argues that in relation to unpleasant events "it is not an uncommon phenomenon to find the emergence of more coherence in narrative accounts over time as individuals construct meaning and attempt to make sense out of their traumatic experiences" (Barclay, 1996: 117).

Another cause of change is that the very act of recounting a life event can bring about a reorganisation of the memory for it. This is due to the processes used in

recounting or interpreting the narrative itself and also to the processes involved in retrieving memories. Bruner and Feldman (1996) suggest that "how a narrative is constructed, its form or pattern, provides us with a basis for understanding or interpreting it - whether the interpretation is accurate or not" (Bruner and Feldman 1996: 291). In emphasising their personal import, Fivush, Haden and Reese (1996) see the recounting of memories as a way of communicating the self.

In view of the limitations described above, it is important for the purpose of this study to ascertain the degree of reliance that can be placed upon personal memories. Conway (1990) suggests that "in autobiographical memory ... it is not usually the case that a memory is completely false but rather that a memory relates to an event which did occur, but not exactly as remembered" (Conway, 1990: 9). Bruner and Feldman further reassure the reader that "most event sequences can be retold in several equally accurate renditions, differing chiefly in the meaning [the informants] give to reported events" (Bruner and Feldman, 1996: 293).

Young children enjoy talking about past events with their caregivers. Fivush, Haden and Reese (1996: 341) believe that "joint reminiscing serves a very special purpose, that of creating interpersonal bonds based on a sense of shared history". Nevertheless, it is difficult for a researcher to draw out remembered events from very young informants. For example, Gopnik and Graf (1988) discovered that three-year-olds were unable to answer the question "How do you know that?" in their research on episodic memory. Therefore they changed their original research instrument and instead presented children with a choice from three possible alternatives, whereupon even three-year-olds were able to remember information about specific episodes. However, although factual information could be recalled, these young children still had difficulty in remembering the sources of their knowledge. In contrast, by the age of five years, "when children correctly identified the information, they usually also correctly remembered the source" (Gopnik and Graf, 1988: 1367).

7.6 Conclusion

Although the number of studies reviewed in this chapter is small, both the findings and methods are relevant to this part of the thesis.

The findings in this review can be utilized in the discussion of the empirical data to be found in chapter nine. They illustrate that a stimulating home environment is more important than socio-economic status in promoting both short-term and long-

term gains in academic achievement. They show that conversations between children and their care-givers, whether at home or on visits elsewhere capitalise upon shared experiences in a way which scaffolds children's efforts. Such conversations help children to remember past events and assist in the formation of meaningful mental links between new information and prior knowledge. Therefore informal environments are very influential in the promotion of learning in young children.

It can be seen that a number of different methodological approaches can be employed in research into opportunities for learning in informal settings. The examples of research design and methods of data collection identified here inform the work described in chapter eight. When these methods depend upon the memories of a respondent, it seems that although they are unlikely to be entirely accurate, they normally bear a reasonable relation to actuality. However, it is likely that children below the age of five years, in particular, will experience difficulty in recovering memories.

CHAPTER EIGHT

CHILDREN'S OPPORTUNITIES FOR LEARNING: METHODOLOGY OF THE EMPIRICAL ENQUIRY

8.1 Introduction

The aim of this chapter is to describe the methodology employed in order to answer the question: "What opportunities do children have to learn about the organic origin of food, both in the context of school and of family, from the age of four to eight years?"

The food items depicted in the photographs described and displayed in chapter five are the main focus of this study. Therefore the enquiry is about the opportunities children may have to see chickens and cows feeding, to observe eggs being collected and cows being milked. It is about their opportunities to discover that meat is the flesh of animals seen on farms. It is about their opportunities to learn about cheese-making, the relationship between grain growing in fields and flour, breakfast flakes and bread. It is about their opportunities to discover the way potatoes grow and the ways in which they may be cooked. It is about their opportunities to plant seeds, to care for growing plants and to harvest fruit and vegetables.

As the findings in chapter nine demonstrate, the children themselves appeared to regard their informal opportunities for learning more highly than those offered in school. Therefore in this ethnographic study, the investigation is not simply concerned with the identification of the sources of children's knowledge. The purpose is also to provide a description of the informal context in which learning takes place. In making a comparison between this and the context of school it is hoped to elucidate the reasons for children's preference.

8.2 Outline

To begin with, there is an account of the research design and the participants in the study. Following this, the research question is detailed and translated into researchable form. Then there is a description of the instruments employed. One instrument, that of diaries kept by parents over three years, constitutes an original strategy which has not been reported in the literature. A description of a pilot study, carried out to evaluate and refine this instrument, is provided. Then the ways in

which the data were analysed are described. Finally, conclusions are drawn about the reliability and validity of the methods employed.

8.3. The research design and methodology

It has been explained that children are believed to develop knowledge and understanding about the material world through both first hand, sensory experiences and also through secondary, socio-cultural contributions. The problem was to design a means to discover what those experiences might be: both in school and family settings. The findings reported in part two of the thesis suggest that simply to ask the children themselves might produce a limited and even a distorted view of their opportunities for learning about the topic. In particular, it was noted that the younger children especially provided intriguing, misleading and incomplete responses to questions about their knowledge. Therefore the design chosen to meet these requirements was an ethnographic one where a case study was made of the relevant experiences of children in the two settings (Manor House and Sea View), described in chapter five.

Although ethnography is described by Denzin (1997: xi) as “that form of enquiry and writing that produces descriptions and accounts about the ways of life of the writer and those written about,” in reality studies which are described as ethnographic limit their focus to one or more topics of interest. For example, Pollard and Filer (1996), who studied children’s developing attitudes to learning, and Mayall (1994), who investigated children’s opportunities to learn about health, both claim that their work is ethnographic in nature. These studies are described in chapter seven.

The means of data collection in ethnographic studies “in its most characteristic form involves the ethnographer participating, overtly or covertly, in people’s daily lives for an extended period of time”, according to Hammersley and Atkinson (1995: 1), but for reasons which are about to be clarified, very little data were collected in that way in the present study. Instead, the term ‘ethnography’ is interpreted as “referring primarily to a particular method or set of methods, ... collecting whatever data are available to throw light on the issues that are the focus of the research” (Hammersley and Atkinson, 1995: 1). As an approach to data collection “it appears to be just about looking, listening, generally experiencing and writing it all down”, notes May (1997: 138), who claims that “the ethnographer is the instrument of data collection”. Nevertheless, he argues that this is “possibly the most personally demanding and analytically difficult method of social research to undertake” (May,

1997: 138), because it requires the researcher to spend a great deal of time in the research setting, to maintain relationships with people connected with the study and to spend months of analysis after the fieldwork.

This approach, then, allows for the collection of evidence from a number of different sources, producing a broad picture of children's experiences. In the present study, data were gathered through first-hand observations by the researcher, from teachers, class libraries and parents as well as from the children themselves.

8.4 The participants

As is the case in the second part of this thesis, all names of individuals and schools have been changed for reason of confidentiality.

The reality regarding the choice of schools for this work is described in chapter five. As explained there, the schools at Sea View were included at short notice. It was not possible, therefore, to involve participants in Sea View as fully as was the case in Manor House for this part of the study. Nevertheless, information was gathered from Manor House and Sea View nursery and primary schools, and from parents and children at both localities. Details of the individuals involved are provided below in the description of the operationalisation of the research.

8.5 Operationalisation

8.5.1 Rationale

Not only may opportunities for learning about the organic origin of food occur in the different settings of school and family, but related knowledge may be developed and refined over a long period of time, from a child's earliest years to adulthood. Thus, the topic provides both an opportunity and a challenge. It provides an opportunity because learning is ongoing throughout the chosen age range of four to eight years. It provides a challenge because it is not possible to observe the opportunities for learning at pre-ordained times either in school-based lessons or on informal occasions outside school.

These factors influenced the operationalisation of the study. With few exceptions, it was not possible to make relevant observations at pre-arranged times in either setting.

An ideal operationalisation for the design of this project would have been a case study of a single cohort of thirty children over a period of four years. If this had been possible the same children would have been asked about their learning experiences at the age of four years when pupils at Manor House Nursery and then at the ages of six and eight years while pupils at Manor House Primary school. In this hypothetical scenario, all subsequent data relating to children's opportunities for learning, both in the school and family settings would have pertained to those same children. They would all have had virtually the same educational experiences in the school setting and all their parents would have co-operated in recording informal opportunities for learning with family and friends. However, for reasons explained in chapter five, the same children were not interviewed at the age of four, six and eight. Neither did all the children attend the Manor House schools. Furthermore, it was possible to enlist the co-operation of only a small proportion of the parents who were originally invited to take part in the study, as explained below.

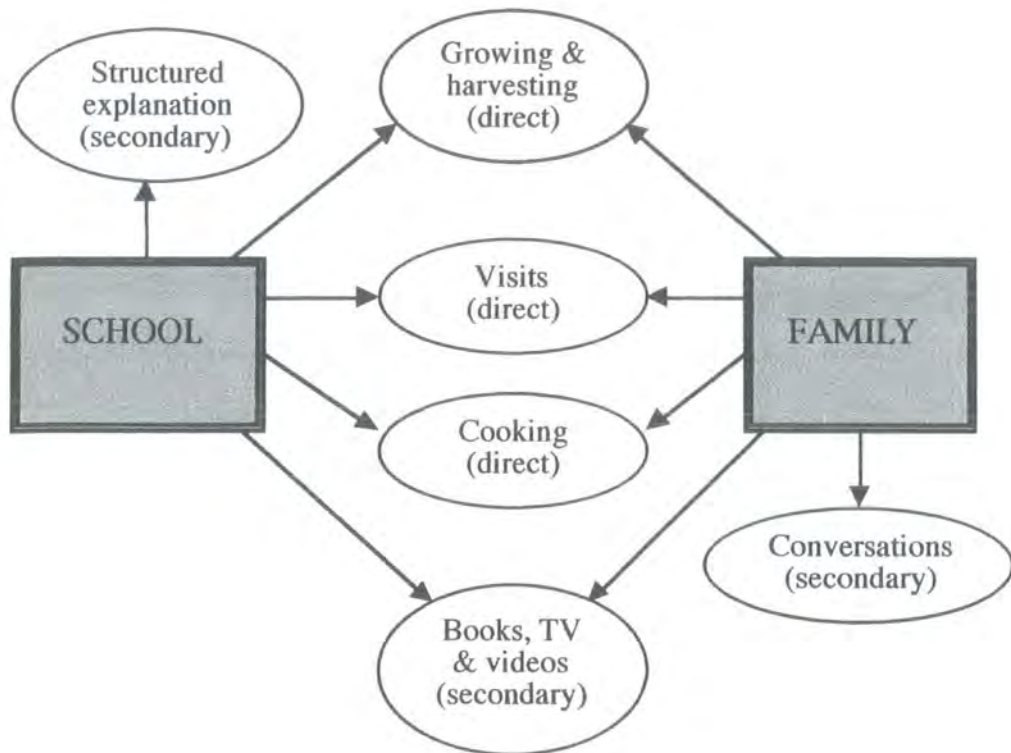
Using the situation described above as an ideal model, the actual operationalisation of the design reflects an effort to construct a model which best approximates to it.

8.5.2 The research questions

The research questions relate to two learning contexts: a) the formal context of school, and b) the informal context of home and family. Another dimension of the study is that the learning opportunities themselves can be classified as direct, first-hand sensory experiences on one hand and secondary sources of knowledge on the other. Secondary sources can be conceptualised as the knowledge of others which are expressed through the symbols of language and visual images. Thus, children might extract information from verbal exchange with other people and from media such as books, computer software, TV and films.

The relationship among the components of the two dimensions of the study is shown in figure 8.1.

Figure 8.1 The components of the study



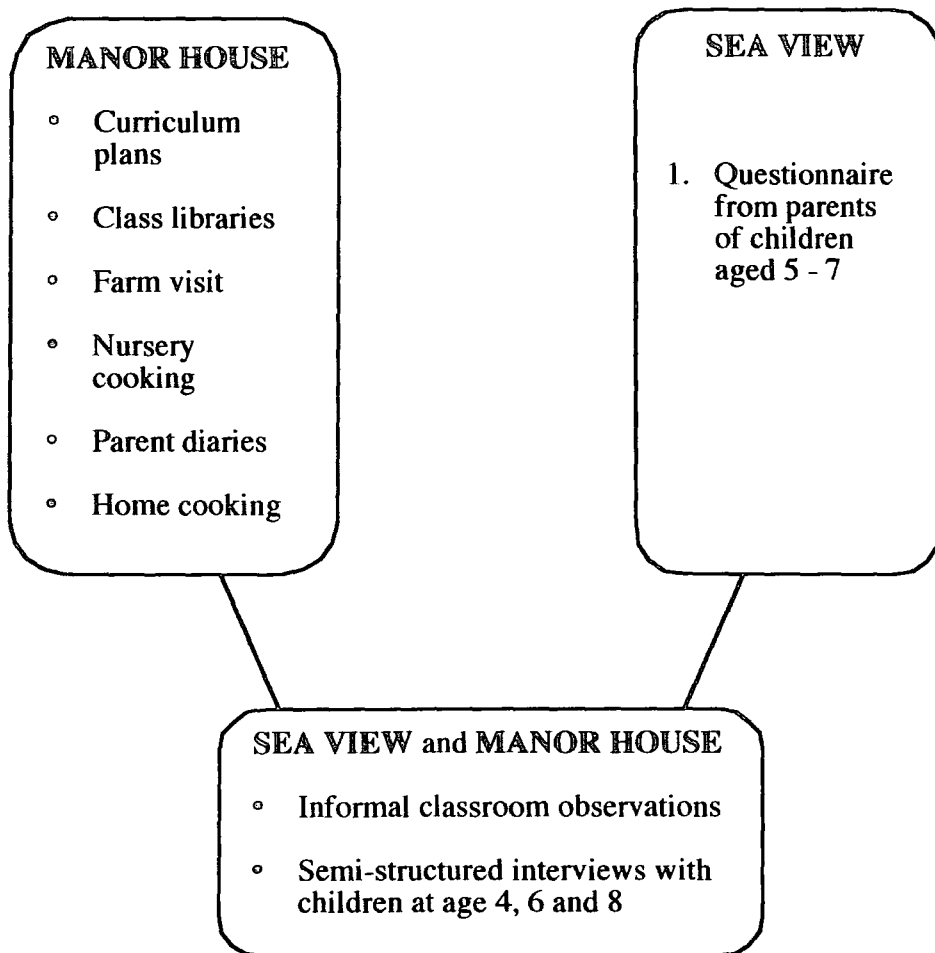
The way the research question was posed as a number of researchable sub-questions is therefore:

1. What first-hand sensory experiences do children have in the school context which might contribute to their knowledge about the organic origin of food?
2. What secondary sources of information do children have in the school context which might contribute to their knowledge about the organic origin of food?
3. What first-hand sensory experiences do children have in the home and family context which might contribute to their knowledge about the organic origin of food?
4. What secondary sources of information do children have in the home and family context which might contribute to their knowledge about the organic origin of food?

8.5.3 Gathering the data

An overview of the sources of data is shown in diagrammatic form in figure 8.2.

Figure 8.2 Sources of data



The way in which data were gathered will now be described in detail.

a) The schools

The nurseries

At the beginning of the project, the researcher spent some considerable time in Manor House Nursery. In addition to conducting the first pilot study of the semi-structured interviews, as described in chapter five, she joined in a number of activities as a participant observer. These included a visit to a farm. Regular classroom activities were observed, including a cooking session conducted by the head teacher with a group of children, which was tape-recorded.

Manor House nursery owned a large collection of books. A selection, chosen for their appropriateness to the topic in hand, was placed in the classroom at the

beginning of each week. The complete collection of information books was examined and details of any relevance to the topic of food were noted. Half of the collection of fiction books was examined in the same way.

The head teacher of Manor House nursery was interviewed regarding her plans for teaching science. Field notes were taken on both this and her written curriculum plans for science.

The time spent at Sea View nursery was much shorter. The researcher spent just two sessions in the activity area during the familiarisation phase with the children, described in chapter five. It was possible only to note some differences between Sea View and Manor House regarding the experiences on offer to the children. These were the incubating of eggs and rearing the resulting chicks and the indoor planting of tomatoes which produced fruit. The head teacher was interviewed briefly in order to clarify some details of these two activities. It was also noted that, unlike Manor House, Sea View nursery had accomplished their farm visit by the time the interviews took place. The farm visited was in fact the same for both nurseries. An assumption had to be made that, because of the influence exerted by the National Curriculum for schools in England, the curriculum plans were similar at the two nurseries. This is because although the nurseries were not legally subject to curriculum directives at the time of the study, there was an expectation on the part of the Local Education Authority that they would prepare their pupils for entry to primary school at the age of four plus. The daily activities observed by the researcher while familiarising herself with the children indicated that this was likely to be the case.

The primary schools

The head of the infant department (of children aged four to seven years), and the class teacher of eight-year-old pupils at Manor House were both interviewed regarding their curriculum plans relating to science and teaching about food. All the interviews with teachers were tape-recorded and later transcribed.

The researcher was given a copy of the schemes of work in science for pupils aged five to eight at Sea View Primary School.

b) The parents

As explained earlier, there were two problems to be solved with regard to the discovery of food-related experiences which take place outside school. Firstly, they

may occur on many occasions and without prior arrangement. It was therefore impossible for the researcher to plan to make personal observations. The second problem was that, owing to their immaturity, the children themselves were not able to give a full account of their experiences.

However, in the case of such young children as those in the present study, their parents were deeply involved in their care. Indeed, it can be said that on many occasions the experiences in which children had the opportunity to learn about food were actually experiences for the parents as well. Therefore, the idea was to search out details of these events from the parents.

i) Parent diaries

There still remained the question of how to collect these details over a time scale of three years. It was in order to solve this problem that the idea was developed of asking parents to keep diaries about their children's experiences.

Pilot study of the parent diaries

As it was a new procedure, a pilot study was conducted. This was to determine the feasibility of diary-keeping by a parent as a way of recording a child's experiences. The researcher approached a friend, Jean, who had a baby. This mother agreed to record the aspects of the material world in which her infant son showed an interest. The researcher and Jean took turns to visit each other's homes every six weeks. At each meeting the diary was read and discussed. As a result of this early diary keeping on the part of a parent the following issues emerged:

- regular meetings were important to give encouragement and to keep the mother on task,
- providing the mother with a fresh focus each time helped to maintain interest and promote accurate observations,
- although Jean was conscientious about taking care of the notebook given her by the researcher, it was decided that a loose-leaf folder would be more suitable in the main study. This would allow the information to be collected, word-processed and analysed after each visit,
- the provision of a black ball-point pen would promote legible writing,
- from conversations and observations made during the visits, it was clear that the information recorded in the diary did not encompass all the items that could have been included. There is no way of telling what other items might have been mentioned if the mother had remembered to record them. Therefore the assumption was made that the records were only a sample of the actual events.

Implementation of the parent diaries

Early in the project, the parents of pupils at Manor House Nursery were approached for volunteers to keep a diary about their child for a period of three years. This length of time meant that the diaries commenced when the children were aged four years, just before transfer from the nursery to primary school and ended when the children were aged seven years, at the end of their time in infant classes.

Of some thirty parents of the pupils at Manor House nursery (those whose children intended to transfer to a local primary school), only sixteen volunteered. Of these, nine dropped out during the first twelve months. Thus only seven persisted in keeping the diaries for the whole of the three years. These factors influenced the sample of parents, which was self-selecting. They exhibited only a sub-set of the normal range of occupations that might be expected in mothers of young children. Three were nurses, one was an assistant bank manager, one was a trainer, one was a valuer for an estate agent and one was a child minder. In other words, all except the child minder (whose charges were the offspring of one of the other volunteers), were well educated and employed in work demanding a high degree of literacy. At the beginning of the project these mothers worked only part-time but by the end, when their children were settled in primary school, most were working full-time. Furthermore, two were also studying part-time for further professional qualifications by the end of the project.

There was a danger that detailed knowledge of the research would influence the experiences provided for the children. A parent might make a special effort to take the child strawberry-picking, for example, or give detailed instructions for the care of garden plants if she had been asked about her child's opportunities for learning about the organic origin of food. Therefore parents were not informed of the exact focus of the research but were asked to record *any* opportunities to learn about food or food-related conversations experienced by their child. In addition, on the occasion of the four-monthly visits by the researcher, a fresh focus was provided by requesting particular information such as a child's favourite TV programmes, hobbies and visits to places of interest. A copy of the first instruction sheet for diary-keeping and a schedule for the other visits are to be found in Appendix V. A typed copy of one of the diaries was selected at random and is to be found in Appendix VI.

None of the children whose parent kept a diary took part in the semi-structured interviews described in chapter five as they were not of an appropriate age at the time the interviews took place. This was just as well, because at first the children

were not enthusiastic about the attention given to them as subjects of diary keeping. For example, they all refused to have their photograph taken by the researcher on the occasion of the first home visit.

ii) Home cooking sessions

At the beginning of the diary project each parent was presented with a blank cassette and asked to make a tape recording when next allowing their child to engage in a cooking session. Only two of the volunteers managed to do this, although all but one indicated that their children did engage in cooking activities from time to time. It proved to be a disappointing and expensive exercise, since most of the fourteen unused tapes were never returned. Therefore, although it would have been useful to have heard some cooking sessions when the children were older, the attempt to do so was abandoned.

iii) Parent questionnaires

Due to the inclusion of Sea View late in the project it was not possible to request diary-keepers from the parents of the nursery pupils there. Instead, towards the end of the project, the parents of pupils in the infant department at Sea View Primary School were invited to complete a questionnaire. This provided an opportunity to triangulate some of the data derived from the parent diaries and from interviews with children. The questionnaires were distributed two-and-a-half years after the semi-structured interviews took place. In all, forty-two questionnaires were returned: a response rate of thirty-one per cent. However, only four of these parents were of the children who had taken part in the semi-structured interviews while at Sea View nursery. This means that the parents of the other eight nursery children at Sea View who were interviewed either transferred them to different primary school or chose not to return the questionnaire.

In order to confirm data indicating that children had opportunities to learn about the needs of growing plants and to learn about the organic origin of fruit and vegetables, parents were asked whether their child had grown anything in the garden during the summer and whether their child had been able to pick fruit or anything else they could eat. In order to confirm that children had opportunities to see examples of food-producing animals, they were asked whether their child been able to see any farm animals during the previous summer.

In order to confirm the claim made by some of the children that they had seen videos of cows being milked, the questionnaire sought details of children's favourite TV programmes and video films. The titles of TV programmes which were tape-recorded were also requested. The questionnaire asked the number of times these films and recordings were viewed. Finally, in order to triangulate the conversations about food described in the parent diaries, the questionnaire asked parents to describe the questions their children ask. A copy of this questionnaire is to be found in Appendix VII.

c) The children

Semi-structured interviews with children at the two localities

As described in the second part of this thesis, ninety children (thirty each at age four, six and eight years) took part in semi-structured interviews about the origin of food. As described in chapter five, many children (especially the younger ones) indicated by their body language as well as verbally their impatience if too long was spent discussing any single picture. Therefore it was not possible to ask each time how they knew the information they gave. The researcher simply asked them as often as seemed appropriate without losing their co-operation.

8.6 Analysis of the data

As there were different types of data it was necessary to employ more than one type of analysis.

8.6.1 Content analysis

In chapters four and five, the content approach to analysis was described as a positivist approach to creating order from the data, when dealing with language as communication (Slater, 1998; Tesch, 1990).

Data provided by children, teachers and the researcher's field notes

Data about children's sources of knowledge collected as part of the semi-structured interviews described in chapter five were analysed for content by the same process of analysis as described in part two of the thesis. In this case, children's responses relating to the sources of their knowledge were the focus of interest. Thus, phrases which capture the essence of children's sources of knowledge about food for hens (for example, "*like birds*", "*Mum told me*" and "*seen them fed*") are recorded in the

spread sheets which are to be found in Appendix III. This information was then collated into the tables which appear in chapter nine, where the percentage of children providing each type of response is shown.

Data provided by parents

Parent diaries

As explained earlier in this chapter, some of the information requested of the diary-keepers was not directly relevant to the present study, but was included in order to provide variety from one researcher visit to the next, in order maintain the participants' interest in the process. As well as this, it was uncertain at the beginning of data collection as to which aspects of the diaries would be particularly relevant. As Hammersley and Atkinson (1995: 24) explain, "the course of ethnography cannot be predetermined". Therefore after the diaries were word-processed by the researcher, an edited version was produced by making a copy and then deleting material irrelevant to this study: for example, details of the child's progress at school. Then the diaries were analysed for content in the same way as was done for the transcripts of the semi-structured interviews. In this case, conversations about food, opportunities to be involved in the care of plants, the harvesting of edible items and visits to farms were of particular interest.

Parent questionnaires

Responses to each of the questions in the questionnaire was analysed in turn. Instead of the spread sheets described above, tally charts were made by hand. This numerical information formed the basis of the material utilized in order to find answers to the research questions.

Tape-recorded cooking sessions

Transcripts of the tape-recorded cooking sessions were analysed for content relating to the nature of the ingredients which contributed to the food being prepared. Children's opportunities to observe physical and chemical changes in the ingredients were also noted.

8.6.2 Discourse analysis

Besides being analysed for content, the tape-recorded cooking sessions were subject to discourse analysis. Here, the intention was to elucidate both similarities and differences in the discourse among the sessions recorded in the nursery school and

the homes of two of the diary-keepers. Of interest was the way the exchanges between adults and children were structured and how that might influence the opportunities for children to learn in the two environments. As mentioned in chapter five, discourse analysis can seem a difficult method to pin down, and the particular type of analysis can also be termed conversation analysis. In chapter nine, though, the focus is upon turn-taking, the length of the sentences recorded, the opportunity for sustained engagement with individual topics and the opportunities afforded for children to make links among the food-related activity of the occasion and their previous experiences.

As Cameron (2001: 161) notes, "If life is a series of conversations, it is by no means an irrelevant or insignificant fact that those conversations take place among persons who occupy certain places in the world and have certain kinds of social relationships with one another". Of interest, then, are relationships among individuals who took part in the cooking sessions and how they affected the dialogue. It was possible to employ Cameron's (2001: 49) contrasting description of classroom exchanges as "typically elicitation-response-feedback" and ordinary conversation "where asking a question typically initiates a two-part exchange, question-answer", as a way into the analysis. She identifies a key inequality of defendants, for example, as that they "are obliged to answer questions but are prohibited from asking them" (Cameron, 2001: 161): an inequality which can extend to school pupils as well.

8.7 Discussion

From the details presented above it is obvious that the ideal design for this study bears only a limited resemblance to its implementation. This is one of the reasons why each of the three sources of information (the schools, the parents and the children) presents a challenge to confidence in the reliability and validity of the findings which are discussed below. It is only through a recognition of the limitations as well as the strengths of the ethnographic approach that this chapter can be brought to a satisfactory conclusion.

8.7.1 School-based data

As explained above, due to the permeating nature of the topic under study it was not possible to make systematic observations of all the relevant teaching which took place. Furthermore, it was difficult to compare the experiences on offer at the schools in the two localities because more details were collected from Manor House than from Sea View schools. Indeed, even if the researcher had been available on

the different occasions when aspects of food (including its origins) were identified in the school curriculum as being taught it would have required a full-scale research project of its own. As well as this, as the teachers themselves made clear, opportunities would have been missed since some of the material was treated incidentally at times which were not prearranged. A further point to be made is that it was impossible to confirm that every item listed in the curriculum plans actually took place on a regular basis.

At best, the information gathered gives an idea of the experiences *offered* to the children. For example, nursery pupils were encouraged to choose from the experiences on offer for much of the time in each session. It was not possible to record which activities were *actually* chosen by individual children. Even in the primary schools it is impossible to say what children learned from the experiences provided for them.

8.7.2 Data provided by parents

Diary data

Because of the atypical nature of the sample of diary-keepers their records cannot be assumed to give a picture of the out-of-school experiences of all the young children attending Manor House schools, let alone those at Sea View. A further issue of generalisability, although not as important as the first, is that only three of the children whose parents kept diaries actually transferred to Manor House primary school: the others transferred to another primary school in the vicinity which was nearer to their home.

Cooking session data

Since only two parents made tape-recordings of home cooking there is no guarantee that they were in any way typical of cooking practices within the homes of the young children in the study. They were nevertheless of interest, as is seen in the report of the findings.

Questionnaire data

It is a positive feature of the parent questionnaires that they were administered to the parents of infant pupils at Sea View primary school, since they provided triangulation for some of the findings from the diaries kept at Manor House and also some of the information provided by children. However, just as with diary-keeping, the completion of the questionnaire was likely to select only the more literate subset from the total number of parents of infant pupils at Sea View. Therefore they

may not have given a picture of the experiences of the sixty-nine per cent of families whose parents did not respond.

The sole means available to check on these missing data was to ask the children themselves.

8.7.3 Data provided by children

The only data consistent with that reported in the second part of the thesis originated from the same semi-structured interviews, since the children were on many occasions asked for the source of the responses they gave. Notwithstanding the relevance of such data for this study, it was impossible to ask this question too often because of the jading effect it had upon the children, as explained above. Therefore, there were numerous instances where the curiosity of the researcher remained unsatisfied.

8.7.4 The ethnographic approach

It is explained at the beginning of the chapter that this study utilizes an ethnographic approach to data collection in order to provide a description of children's experiences. In doing so, it takes a realist approach. So, whereas "many writers [of ethnography] have post structuralist or post modern approaches that reject the very notion of objectivity, many others are still anxious to be persuasive and rigorous in their work" (Siraj-Blatchford and Siraj-Blatchford, 2001: 205).

However, according to Hammersley and Atkinson (1995: 6), ethnographic research does not match positivist canons and "as a result it came under criticism as lacking scientific rigour". Furthermore, Scott and Usher (1999: 147-148) describe claims of realism as naïve because "data can never be value free". They argue that "any realist position that a researcher chooses to adopt has therefore to take into consideration the inescapable limitations imposed on the researcher by their locatedness in particular discourses, power-plays, environments and time". For example, Cohen, Manion, and Morrison (2001: 156) caution that participants may not portray the real situation: by "deliberately distorting or falsifying information, or [being] highly selective". What is more, the presence of the researcher may alter the situation under study, as "participants may wish to avoid, impress, direct, deny, or influence the researcher" (Cohen, Manion, and Morrison, 2001: 156). Therefore although the teachers, parents and children were not told exactly what aspect of the topic of food was under scrutiny, the very presence and activities of the researcher could have influenced the events recorded. Even the desire to please the researcher and perhaps

the wish to conceal details regarded as shameful in some way might have influenced the way the participants responded to questioning.

These are reasons for reflexivity, according to Delamont, (1992: 9), where “the researcher ... is constantly self-conscious about her role, her interactions, and her theoretical and empirical material as it accumulates”. In response to this advice, the researcher considered her role and interactions, being careful to avoid comment on her observations with adults or to enter the role of a teacher herself when talking with children in school.

Reservations are also expressed in chapter seven concerning the reliability of autobiographical memory. As well as this, a number of difficulties when working with young children are outlined in chapter three.

In recognition of all these limitations, the question must be asked, “Under what conditions, and under what models of inference, can we make valid generalisations from limited observations?” (Schon 1991: 344). The suggestion is made by Silverman (1993:157), that uncertainty about the reliability of the data is a reason for triangulation, “which involves multiple sources of data collection”. Acknowledgement of this advice is described above, as data were collected from teachers, parents and children, using a variety of methods. The findings from these different sources can be compared and contrasted by means of triangulation.

There is still the challenge of “how to write up multiple realities and explanations” (Cohen, Manion, and Morrison (2001: 157). According to Ely and her colleagues (1997: 377), “writing ... can never be viewed without considering of its situatedness in the contexts of particular moments, places, agendas or ideas”. Nevertheless, Hammersley and Atkinson (1995: 6) maintain that the strength of ethnography is its naturalism: “the primary aim should be to describe what happens in the setting ... and the contexts in which the action takes place”.

8.8 Conclusion

Although it is suggested by Van Maanen (1988:125) that a variety of “literary and rhetorical devices [be] used to represent the results of fieldwork”, the purpose of chapter nine is to produce a straightforward report which is both respectful of the data and of use to educators. By acknowledging its limitations, yet attempting to illuminate matters that were previously unclear, it is hoped that those concerned with the education of young children will better understand their opportunities for

learning. In particular, it is hoped that their informal sources of knowledge will be elucidated.

CHAPTER NINE

CHILDREN'S OPPORTUNITIES FOR LEARNING ABOUT THE ORGANIC ORIGIN OF FOOD: THE EMPIRICAL FINDINGS

9.1 Introduction

The aim of this chapter is to present and discuss the findings derived from the ethnographic study. They relate to the opportunities for children, from the age of four to eight years, to learn about the organic origin of food. These sources of children's knowledge occur both in the school and the family context.

9.2 Outline

The findings are divided into two parts. The first part (section 9.3), consists of an inventory of the possible sources of children's knowledge about the organic origin of food. In the second part (section 9.4), each item of the children's knowledge is treated in turn. The specific nature of the information (relevant to each knowledge item) to which children have access is identified and described.

The discussion which follows is concerned first with the children's own attribution of the sources of their knowledge. Then it is concerned with the reliability and validity of the data from different informants. Finally, the discussion turns to the predicted outcome of the study, before conclusions are drawn.

9.3 An inventory of the sources for children's ideas

All the experiences which might have contributed to children's ideas about the origin of food are first summarised in table 9.1. Then there is an ethnographic narrative describing the details of these experiences.

9.3.1 The inventory table

The table divides the sources of children's knowledge first into those which were direct, first-hand experiences as opposed to indirect or secondary ones. Then there is a division into those experiences which occurred in the formal context of school on the one hand, and those which occurred in the informal context of family and friends on the other. The experiences available to children in school were normally repeated year by year. Therefore the experiences of the nursery pupils (aged four years) who

were interviewed in this project would have been similar to the early experiences of those pupils who were interviewed at age six (in their second year in the infant department of the primary school) and at eight years (in their first year in the junior department of the primary school). The table also provides a brief description of the experience and an indication of the frequency with which it occurred.

Table 9.1 Classified inventory of children's sources of knowledge about the organic origin of food

Direct (first-hand) or secondary (indirect) experience	School or family-based experience	Type of experience	Frequency of experience: 3 = very, 2 = moderately frequent, 1 = infrequent
DIRECT EXPERIENCES	a) School & family	Farm visits	3
		Planting seeds	3
		Tending plants	2
		Cooking sessions	2
		Seeing chicks hatching	1
	b) Family	Harvesting edible items	2
		Feeding hens	2
SECONDARY EXPERIENCES	a) School	Receiving structured information about food	3
		Class library books	2
	b) School & family	TV/Video	3
		Books	2
	c) Family	Answering children's questions about food origins	3
		Misleading names of processed food items	1

9.3.2 The ethnographic narrative

9.3.2.1 Direct, first-hand experiences

a) Direct experiences in both school and family contexts

Farm visits

Schools in both localities visited the same farm and children had similar experiences. On the Manor House visit observed by the researcher, the children had a ride on a trailer pulled by a tractor. They were allowed to feed goats and sheep. They could hold newly-hatched chicks and stroke a foal. The farmer's assistant identified each animal and told the children whether it was a 'boy' or a 'girl'. She also explained what each animal liked to eat. The most striking feature about the children's behaviour was their excitement, which was manifested in the amount of physical activity they displayed. They were so involved in running and jumping, and in stroking and feeding the animals, that it would have been difficult to engage their attention for any detailed explanation of the reasons the farmer had for keeping them.

Although the village of Sea View was industrial in origin, fields occupied by cows were to be seen within walking distance of the homes of many of the children. As well as this, 36% of the parent questionnaires reported that children were taken on special visits to farms and 12% that they visited farms on holiday. They were able to stroke and feed some of the animals. Farm animals were also mentioned as being on view for children at leisure destinations such as theme parks.

All the Manor House parents who kept a diary reported that their children were able to see farm animals at close range at least twice during the three years of the study. In some instances, visits were made to establishments which were specially designed to allow children to encounter the animals. Children were sometimes allowed to hold or stroke baby animals such as chickens and lambs. Two children were able to bottle-feed a young animal. Two children spent a holiday on a farm and were able to watch cows being milked.

Whereas the purpose of the school farm visits was to promote the learning outlined in their curriculum plans, it seems likely that those which took place with family and friends were in response to children's wishes. This concurs with the findings of

Tizard and Hughes (1984), mentioned in chapter seven, that parents were willing to consider children's wishes in plans for family activities.

Planting seeds

Children were shown how to plant seeds in soil and how to water them in both the nursery and infant classes. At age six, children carried out an experiment to see whether seedlings need water, light and soil in order to grow. 24% of parent questionnaires and 57% of parent diaries described children planting seeds at home.

Tending plants

Children helped to water and add liquid fertilizer to a grow bag in which three tomato plants were growing in the foyer at Sea View nursery. 19% of parent questionnaires mentioned children helping to tend bedding plants in the garden and 2% mentioned planting bulbs in the autumn. 71% of parents who kept diaries described children's experiences of planting, watering, weeding and trimming border plants. In school, the six-year-old children planted bulbs in the autumn and sprouted carrot tops, onions and potatoes in water on the window sill.

Cooking sessions

Several children mentioned cooking experiences outside school, with parents or grandparents. Nevertheless, the teacher of eight-year-old children at Manor House stated the belief that her pupils had little experience of cooking outside school, apparently unaware of the different adults who shared in caring for the children. This finding confirms that of Tizard and Hughes (1984), who found that teachers were largely unaware of the learning experiences on offer to children in their home environment.

Manor House nursery planned for children to have several opportunities to take part in cooking sessions. Drop scones, biscuits, bread, buns, yogurt and cheese were mentioned. Children were encouraged to use their senses to explore the properties of the ingredients, such as the components of eggs, sifting powdery flour, melting butter and smelling spices. They could observe changes in the ingredients as they were mixed, allowed to ferment, or cooked. The development of descriptive vocabulary was regarded as an important part of this work.

Children in the infant department also experienced practical cooking sessions in small groups, when they concentrated on the physical and chemical changes which took place in the ingredients.

Three cooking sessions were tape-recorded: one by the researcher at Manor House nursery and the other two by diary-keeping parents at home.

(i) A school-based, nursery cooking session

The policy at Manor House nursery was that children were told when a cooking session was about to take place. As many of the children as wished could join the group. As a result, the tape-recorded session involved eighteen children (ten girls and eight boys), of whom sixteen were present in the group at any one time. It is not surprising, therefore, that although the teacher's words are captured on the tape-recording, some of the utterances of the children are indecipherable. A transcript of the recording is to be found in Appendix VIII.

The cooking event was analysed for its contribution to children's knowledge and understanding of the origin of a familiar food item, ginger biscuits. In accordance with the stated curriculum policy for the nursery, children were encouraged to make careful observations and to develop a descriptive vocabulary. Although this approach was therefore language-oriented rather than science-oriented, the use of discriminatory language when detailing the properties of the ingredients of the biscuits had scientific value. Thus the teacher enabled her pupils to distinguish salient attributes, using their senses of sight and taste, when examining the ingredients. For example, the refinement of visual discrimination was encouraged when the first two ingredients were examined. Although both flour and sugar are white, their appearance was contrasted in the following sequence (T = teacher; C = child):

T. Does it [the sugar] look the same as the flour?

C. No.

C. Silver.

T. It's a bit sparkly, isn't it, this sugar? Yes, you're right.

Discernment when observing the physical attributes of the ingredients was encouraged. For example, noting the viscosity of condensed milk:

T. Now, what did you call this, Christopher?

C. Sticky milk.

T. Yes, you're right. It is sticky milk. It's called condensed milk. It is sticky. It tastes delicious. If you're very, very good I'll let you have a taste.

T. Ooh, it runs right off the spoon. Can you see? Sticky milk. Now let me see. I don't think I'd put my hands in there, they'd get all sticky.

Discrimination in using the sense of taste was encouraged in the children's exploration of the sugar and condensed milk:

T. Right! Who would like to have a taste? One finger ... You can dip your finger into whatever you like for a taste. Now, Christopher, you start.

T. Do you want to taste something, Gemma? ... James? Does that taste good? Does it taste sweet, do you think? Does it taste sweet? ... Would you like a taste, Darren?

C. Yes.

C. I like sugar, I like sugar!

T. Which of these do you think will taste the sweetest? Don't touch, just tell me. Do you think the sugar will taste the sweetest? What do you think, Kim?

C. Sticky milk.

T. Sticky milk? I think that's the sweetest. Sugar's very sweet as well.

By involving the children in weighing the ingredients their appreciation that the preparation of food is a rigorous process was encouraged:

T. Now, we've got to do some weighing and measuring. Let's start off with some margarine. Who can point to the margarine? Right. Jamie, we're going to start with the margarine. We need 160 grams. We'll have the big spoon. Right. Can you see, Christopher? Can you see the red pointer? Can you see it moving? Is it moving? I would like it to point to there. Can you see the number two, there? It's got to come just before that. Right! You tell me when the red line comes to there. You keep watching. Is it there yet?

C. No.

T. A tiny bit more! Right! We'll pop that into the bowl.

A series of physical changes was imposed on the ingredients. First, children were encouraged to use both the sense of sight and of hearing when observing the change in the flour brought about by sieving:

T. It's a sieve. Listen. Listen to it. Can you hear the noise it makes?

T. Who can see some lumps [in the flour]? Let's see what happens when we put it into the sieve. It's just like snow. ... Have a look and see if there are any lumps coming through. Are there big lumps coming through?

Then each child took a turn in mixing the ingredients together, noting that the individual items disappeared:

T. Right, Jamie, will you stir it round and round and round. All mixed together so that you cannot see the sugar and you can't see the margarine and you can't see the condensed milk. Until it looks all just one big ... sticky mess.

T. Let Nathan do some stirring. Oh, the sugar! Where's it gone? Can you still see it?

C. I can see melting sugar.

T. It looks as though it's melting. It's all yellow, it's all the colour of the margarine.

Next, they smoothed out the mixture, using a rolling pin:

T. Now, we're going to roll this out We need a little bit of flour here. Now, I want you, Julie, to carefully roll this out. Carefully, with the rolling pin.

Finally, they shaped the sheet of dough with pastry cutters into the form of vehicles:

- T. Right Julie, would you like to cut out a nice bus? Lift it up carefully. You're going to make a car, Christopher.
C. Brrum, brrum.
C. I know what I'll do. I'm doing a tractor and a wagon.
C. Bop, bop bop!

In conclusion, the chemical change which took place as the soft dough was baked, being dried and hardened in the oven was noted as the children were allowed to eat the cooked biscuits. The teacher said, "Now, the biscuits are not soft and squishy any more! They are quite hard."

Overall, then, the baking event allowed the children to observe in detail the basic ingredients of a common food item and have direct involvement in the physical and chemical changes that were imposed upon those ingredients in order to transform them to an edible state.

(ii) Two family-based cooking sessions

Emily (aged four years) and her mother baked a gooseberry crumble and a ginger cake. On analysing the transcript for content it shows that Emily was able to have more first-hand sensory experiences at home than at the nursery. For example, she accomplished all the mixing herself, and in doing so noted the physical properties of the ingredients. For example, the stickiness of the cake mixture (M = mother; E = Emily):

- M. Mm. Get all this in, as well. It's quite sticky, I think.
E. Quite sticky!

Also, although her inclination had to be kept in check, she was more able to explore the ingredients through her sense of taste than would be possible in the nursery:

- E. Is that for me? Ahh!
M. Right. Come on, get mixing up, missis! There'll be nothing left if you keep nibbling!

Emily was actively involved in the weighing process, something she remembered from a nursery cooking session. At home, though, Emily could engage in a prolonged exchange which in total involved twenty-one turns each. For example:

- M. Do you want to weigh some flour for me?
E. Yes. You tell me when to stop.
M. You can tell me when to stop. Put the right weights on first. Right, ounces. Is that eight ounces?
E. I think so. It's got an 8 and an O and a Z.
M. That's right. That OZ is short for ounces. That. Put it in there. When they balance, then you can stop. Raisins (*opens packet*).

E. Enough?
 M. Has it balanced? I think it still needs a little bit more, still needs some more.
 M. That's right. Now... There's too much in there now, isn't there?
 E. OK.
 M. Take it out with the spoon.
 E. OK. This much?
 M. Just take teeny bits out, at a time, to make it one level.
 E. They're the same.

Another difference between the nursery and home cooking event is that whereas at the nursery the children were merely encouraged to observe, at home Emily was stimulated to reason and take part in decision-making:

M. What else do you think we should put in there? ... Emily?
 E. Er, some eggs.
 M. Do you reckon? That's for the cake. What about in this, just for making these gooseberries very soft, what do you think we should put in?

Daniel (aged five years) had already transferred from Manor House nursery to primary school by the time this cooking episode was tape-recorded. He helped make rice crispy cakes and rock buns. Content analysis shows that, in a similar fashion to Emily, Daniel had more opportunity for sensory experiences during the session at home than he would have had at the nursery. For example, he tasted and ate some quantity of the ingredients before they were cooked (M = mother; D = Daniel):

D. Can I taste the stuff yet?
 M. Well ... seeing as you've been a good lad ... I think I'll let you. Do you think that's enough crispies in now?
 D. I think that's enough made.
 M. Come on, then. You stir that in. Mam will put the crispies in the cupboard. Daniel, you're eating more than you put in!
 D. Aagh! (*makes a sound with mouth full*)

As with Emily, Daniel mixed the ingredients:

M Give that a stir!
 D. Mmm. (*sound of stirring*)
 M That's it! Give it a good stir, all the way round.
 D. I am!
 M. That's right, keep stirring? Not so fierce! Right, stir them in.

Having placed the crispy cakes in the oven, Daniel and his mother turned to the task of making the rock buns. Once more, Daniel was able to examine, chop and stir in the ingredients but unlike Emily, he was not involved in weighing and measuring:

M. Pour the flour right in, now. Put it all right in. That's it. Put it down there. We'll put a bit of salt in there. All right. Now, let's have a look. What do we need? Oh, I say. I want some margarine.
 D. Can I tip it in?

M. Not really, 'cos Mummy's measuring it as she goes. What you have to do, right, is (*sound of stirring*) put the margarine in the flour like that, into little bits (*sound of chopping*). That's it. Chop it all up. Are you chopping it?

D. It's all chopped.

M. Ay? It's all chopped? Now. Do you know what you do now? Put your hands in like this, right? Now, rub the margarine into the flour, like that.

D. Now put, ... now put the raisins in?

M. No, you have to do that with the margarine first. You're making them, Mummy's not making them. No! Rub the margarine in first! That's it, right into all the flour. Now we'll make rock buns.

D. Ha, ha.

His mother was keen to let Daniel rub in the mix himself, even though this required a considerable amount of demonstration and guidance:

M. Put your hands in the flour, or your hands are going to get really sticky. You have to put them right into the flour and lift it. Do you want me to do a little bit for you?

D. No. I've done it.

M. I don't think so. You have to do it very good, you know. You have to do it all. So it's all right in. ... OK? Let's have a look. Lift your hands up just a minute. Can I just give it a little go, and then you can. You see, you have to lift your flour, like this. Put your hands over the bowl, or you'll get all bits all over the place. That's it!

D. I'll do it now, Mam.

M. Right, you do it, then. You have to make it look like little bread crumbs, like that.

D. Mm?

M. Rub it through your fingers like that. Can you do that?

D. I'll do it.

M. Don't flick it! Do it gently. ... Let's have a look? Look at your fingers.

He added the milk and egg to the mixture, albeit with a good deal of help:

M. Have you got that all mixed? Let's have a look. Lift your hands up a minute. Right, now what you do ... You make a little hole in the centre. Now put your hands now, over the dish. Now put them in the sink and wash them. (*sound of splashing*).

His mother made several attempts to help Daniel understand scientific ideas during the session, an endeavour which was only partially successful. She began by engaging his prior knowledge of how to melt chocolate, taking care to keep his clothes clean in the process. During this procedure, she made an attempt to help Daniel understand that chopping up the block of chocolate would provide more surface area exposed to the heat, but Daniel was either unable or unwilling to think beyond the necessity for melting to take place:

M. Do you know how to melt the chocolate first?

D. Yes.

M. Just a minute, then. Are you going to break it up into bits?

D. To make some chocolate?

M. Put it in the dish, then, or you'll get it all over your clothes. Break it up.

D. I cannot.

M. It's quite hard, isn't it? Do you know why we break it up into small bits like this?

D. Yes.

M. Why?

D. Because we have to make rice cris..., rice crispy cake.

Continuing the theme of melting the chocolate, his mother tried to discuss the idea that the microwave would heat the chocolate in order to melt it. Daniel, however, concentrated on what he could see:

M. If you hang on a minute, we'll put that in the microwave, shall we? (sound of microwave motor). Do you know what the microwave does?

D. Yes.

M. What does it do?

D. Turns it round.

M. It goes round, doesn't it? That's to make sure that it's cooked nice.

While the chocolate was melting Daniel's mother introduced him to the idea of a food chain: he eats chicken pieces, the chicken in turn has eaten bread. However, Daniel turned to a connected topic, that of feeding horses, which he could relate to his own experience:

M. Can you remember what you had for dinner?

D. Powerbites.

M. Do you know what's inside powerbites?

D. Yes. Er, chicken.

M. Chicken. Do you like chicken? What do they feed the chickens on? In Uncle Stuart's garden?

D. Bread.

M. Bread. What else? What else did you give them?

D. We give the horses apple.

M. Uh huh. Why do you think we give horses apples?

D. Cos, cos horses don't like carrots.

In a second attempt to discuss the origin of food, Daniel's mother asked him about the origin of the main ingredient of their rice crispy cakes. Although the following conversation is similar to some of those in the semi-structured interviews reported in chapter six, neither Daniel nor his mother was aware of this:

M. Do you know where rice crispies come from?

D. Yes.

M. Where?

D. Shops.

M. Ha, ha, yes (laughing). Yes! They do (sound of stirring).

Alongside the task of making rock bun mixture, the topic of healthy eating was introduced. The occasion was Daniel's eagerness to lick up some spilt sugar:

M. What happens if you eat too much sugar?

D. I don't know.

M. You do know, I told you before. What does it do to your teeth?

D. It makes your teeth bad.

A number of fiction books featured food in various ways as well. As the provision of food is an important part of many social events, a number of the stories involved detailed descriptions of meals or picnics. One, titled *Pancakes for Supper*, described both the ingredients and the procedure for making pancakes. The traditional tale, *The Little Red Hen*, described all the stages in bread-making, from planting the corn to eating the loaf.

(ii) Books at home

Whereas information books featured largely in classrooms, they were only mentioned on 4% of occasions in connection with responding to children's questions at the homes of the diary-keepers.

TV/Video

Children's favourite television programmes were often tape-recorded. For example, 60% of the questionnaires described this, but neither *Blue Peter* nor *City Slickers* were mentioned, the two programmes from which the children claimed to have gained their information about cows being milked. However, 26% indicated that the child watched a favourite video film eleven times or more.

All but one of the questionnaires noted that the child watched video films. However, neither *The Fox and the Hound* nor *Jack and the Beanstalk*, the two Disney films mentioned by the children as a source of information, was mentioned at all. Nevertheless, 76% of questionnaires indicated that the child watched a favourite video film eleven times or more, in which the general designation of '*Disney films*' featured.

This information provides insight into a very much repeated opportunity for learning, should a child own a video recording or film providing appropriate information.

c) Secondary experiences in a family context

Answering children's questions about food origins

Although the conversations recorded in the parent diaries must represent only a small sample of those which actually took place, one hundred and two conversations about food are described. In every case, the conversation appears to have been initiated by the child rather than an adult, a finding which concurs with that of

Tizard and Hughes (1984), who remarked on children's determination to find out about their world through persistent questioning.

Unsurprisingly, the most common context mentioned for conversations about food was at meal times. 22% of conversations arose in relation to the food children were eating. The next most common context was during food preparation. 13% of conversations took place while it was being cooked. Children observed the process and sometimes were allowed to help. Gardening and trips to the countryside provided the next most common contexts: there were 8% in each case. In contrast, books provided the context for only 4% of conversations, and television 1%.

All the children engaged in at least one conversation about food during a meal. While more girls than boys initiated conversations during food preparation, since only seven children were involved it is impossible for any generalisation to be made about gender in relation to this context.

By far the most common topic in the conversations about food was its origin. 55% of all the conversations recorded were related to this. All the children discussed it at least twice. Two examples illustrate these conversations. Bryony (at age four) asked where the vegetables had come from, while eating Sunday lunch. She was told the potatoes, carrots and turnips had come from her grandfather's garden. She then asked what other kinds of food there are, besides vegetables. Meat, bread, rice and beans were all mentioned. After the meal, Bryony looked at a book and began to find out about food categories such as proteins and minerals. Another child, Daniel (at age four), asked where prawns came from while helping his grandmother clean prawns for tea. On being told that they came from the sea, he asked if prawns can swim. Then he asked whether people eat the eyes of these creatures.

Harvesting radishes and lettuce from the garden provided the context for this conversation about the needs of growing plants between Emily (at age six years) and her mother:

E. I'll look for some big radishes.

M. OK.

E. Here's a **huge** one, but it's not as big as the one Laura [her sister] found. Why aren't there many big ones?

M. They haven't had a chance to grow yet, and they need watering.

E. Does water make them big?

M. Yes. They need it to grow. Shall we plant some beans?

E. OK. Can we plant some tomatoes?

M. They need somewhere hot to grow, like a greenhouse.

E. We could put them in the shed.

M. They wouldn't get enough light in the shed.

Conversations about healthy eating were initiated by four children. They seemed to be the result of recent school lessons. For example, Alison (aged six) asked questions about what is healthy food and what is not. She expressed preferences for the contents of her packed lunches, wishing to replace chocolate biscuits with fresh fruit and yogurt.

Details of the content of the conversations about food is shown in table 9.2. A few conversations dealt with more than one topic.

A striking feature of the conversations is the way individual children pursued the same topic over an extended period of time. An obvious reason for Alison's persistence was a life-threatening situation. At the age of four-and-a-half she experienced an allergic reaction after eating a confection containing peanuts. Over the following six months she initiated conversations about nuts and allergies many times, of which five were detailed in the diary.

Table 9.2 Content of conversations about food

Topic of conversation	Number of times discussed (n = 102)
origin of food	55
care of plants	11
healthy eating	7
nutritional types	7
changes during cooking	6
digestion	5
allergies	5
food preservation	4
safe to eat?	3
consistency	2
ingredients	2
varieties of fruit	2
it is cruel to eat animals	2

Bryony frequently linked her bodily experiences, such as stomach ache, with her food intake. She initiated five conversations about digestion over a period of ten months.

Sometimes the children's conversations almost took the form of a game. Thus, Grant would ask the origin of fish every time it was presented for him to eat. His mother responded by repeating his favourite story about how fishermen set off in their boats and used nets to catch the ingredient of his meal.

Many conversations appeared to be the result of simple curiosity. Frank's mother recorded eleven food-related conversations over two years, of which six were questions about the origin of food. For example, while on holiday at age four he asked how candy floss is made. Shortly after his fifth birthday he asked, "*Do chicken legs come from real chickens?*"

The parent questionnaires recorded children's questions as well. Only one questionnaire indicated that a child did not ask as many questions as the parent would like. At the other extreme, another filled her sheet with examples of the questions her child asked and then added the comment, "*These are just the ones she asked while I was filling in the form*". How things work, household jobs, the weather and seasons were the subjects of the questions most frequently asked. However, of the eighty-eight questions recorded, four were about the origin of food and two about the health-related issue of why sweets are bad for you.

Misleading names of processed food items

The names of some processed foods designed to attract young children have the potential to be misleading about their origin. For example, items mentioned by the diary-keepers in a weekend's diet of children at the age of four include 'turkey aeroplanes', 'alphabet soup', 'fish fingers' and 'jelly babies'. However, no evidence could be found to support the idea that these names misled the children in relation to the origin of the foods concerned.

9.4 The nature of specific experiences and their relevance to children's ideas

In this section, each item of children's knowledge, as recorded in chapter six, is treated in turn. Possible sources for each item are summarised in the form of a table, where details of the experiences outlined in the inventory are provided, together with the origin of the data. The relevance of the known sources is discussed in relation to the children's knowledge.

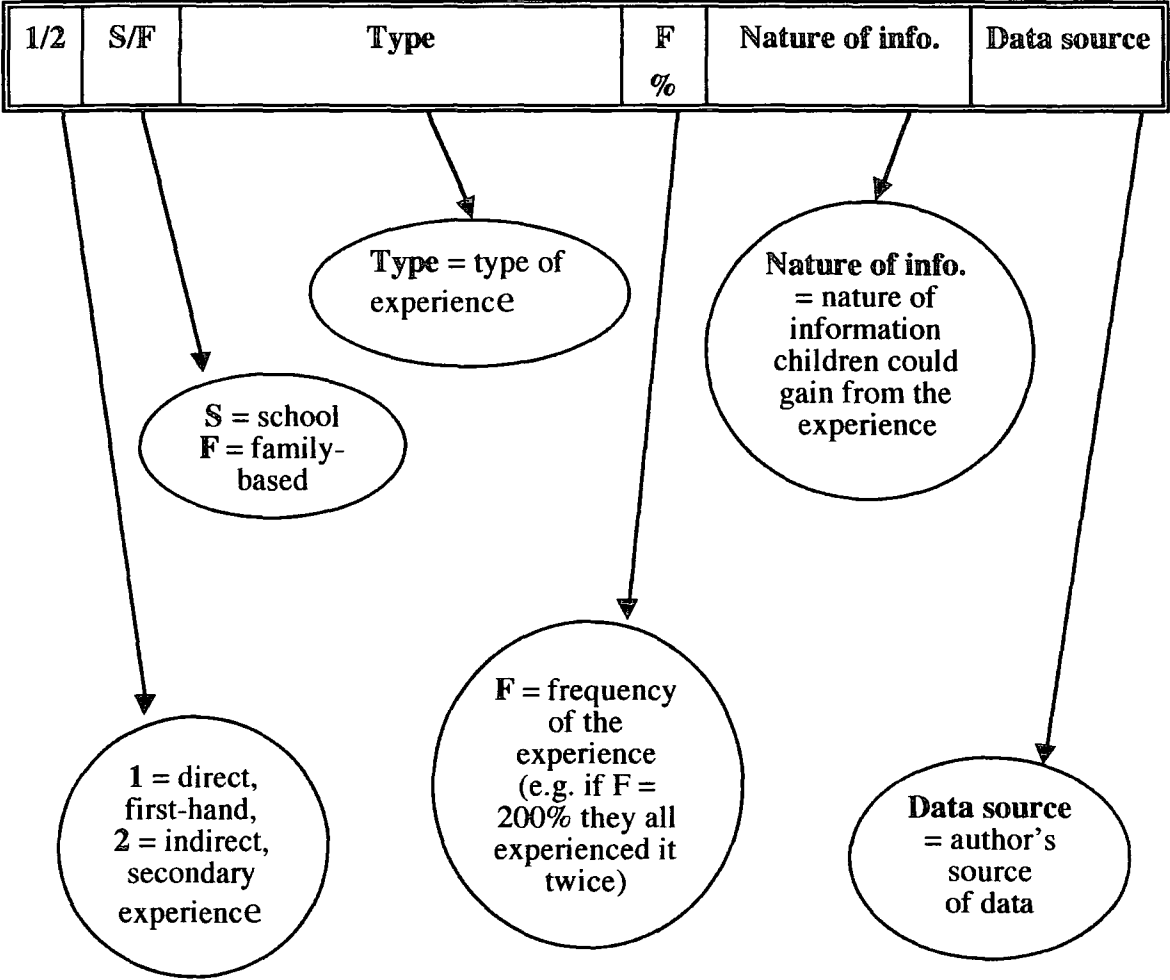
Children's ideas about the organic origin of food are treated in the order in which they are reported in chapter six, as shown below.

Whereas in chapter six these knowledge items were presented separately at the three ages of four, six and eight years, in this chapter a percentage of the total of ninety children who indicated correct knowledge of each item is provided.

Children's ideas about the organic origin of food		Prevalence
a)	Eggs come from hens	83%
b)	Meat comes from farm animals	66%
c)	Milk comes from cows' udders	87%
d)	Lettuce is grown	49%
e)	Tomatoes are grown	48%
f)	Cheese is made from milk	19%
g)	Chips are made from potatoes	77%
h)	Bread is made from flour	27%
i)	Corn flakes are made from corn	43%
j)	Hens eat grain, crusts, vegetation, worms, etc.	71%
k)	Cows eat grass	93%
l)	Plants need water	89%
m)	Plants need soil	37%
n)	Plants need sunshine	37%
o)	Plants need fertilizer	7%

An individual table summarises the known possible sources of knowledge for each of these ideas. The first four columns can be matched to those of table 9.1 (the inventory), but in the frequency column a more exact indication is provided of the percentage of children who are believed to have had the experiences relevant to their ideas. The final two columns indicate the nature of the information and the origin of the data source for it. A key for the tables is provided in figure 9.1.

Figure 9.1 Key for the individual tables



a) Children’s knowledge that eggs come from hens (prevalence - 83% of children)

Table 9.3 summarises the experiences which are possible sources of the children’s knowledge. The idea that eggs come from hens was very prevalent among all the ages of children who were interviewed. This can be related to the finding that children received an appropriate explanation both in the nursery and infant classes. It was reinforced by the use of picture books, and further by a video film at Manor House nursery.

Table 9.3 Children's sources of knowledge that eggs come from hens

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Seen birds' nest in playground	2	Hens lay eggs	Child int.
1	S	Quail eggs hatching (Sea View, age 4)	40	Eggs produce chicks	Teacher & researcher
1	F	Seen hens & eggs	4	Hens lay eggs	Child int.
1	F	Farm visits etc.	23	Hens lay eggs	Child int.
1	F	Seen chicks hatching	2	Eggs produce chicks	P. q'aire
2	S	Teacher explanation (age 4 & 6)	200	Hens lay eggs	Teachers (Ch. int. 1%)
2	S	Class library reference books (age 4 & 6)	200	Hens lay eggs	Researcher
2	S	Pictures & video (Manor House, age 4)	60	Hens lay eggs	Teacher
2	S/F	TV/Video	11	Hens lay eggs	Child int.
2	S/F	Books	4	Hens lay eggs	Child int.
2	F	Explanation by family members	8	Hens lay eggs	Child int.

Despite this prevalence of knowledge, first-hand experiences were not so much in evidence. One example was the presence of some quail chicks at Sea View nursery. The eggs which produced the chicks had been incubated in the school and hatched a week before, indicating a relationship between birds and eggs. At the time of the semi-structured interviews, the birds were in an open-plan classroom for all to see and hear. Even so, only two of the twelve children interviewed at Sea View nursery cited a school-related experience relating hens and eggs as a source of their knowledge. On the other hand, one eight-year-old still remembered his own similar nursery experience regarding the quail chicks four years previously. Other opportunities for children to see chicks hatching were rare.

In all, it seems that secondary experiences account for this knowledge in many children.

b) Children's knowledge that meat comes from animals (prevalence - 66% of children)

Table 9.4 summarises the experiences which are possible sources of the children's knowledge. Despite the fact that over half the children could name at least one animal from which meat is obtained, only two had first-hand experiences of a live animal becoming a source of food. Furthermore, it is unlikely that any films or photographs depicted the process, since it is generally regarded as distasteful. Therefore it must be assumed that children have been told the names of the animals from which meat comes. Indeed, as well as the explanation provided by teachers that meat comes from farm animals, this could have been in response to the children's own questions.

Table 9.4 Children's sources of knowledge that meat comes from animals

1/2	S/F	Type	F %	Nature of info.	Data source
1	F	Caught mackerel on holiday	14	Edible flesh comes from an animal	P. diary
1	F	"Dad shoots rabbits"	1	Meat comes from an animal	Child int.
2	S	Teacher explanation (age 6)	100	Meat comes from farm animals	Teacher
2	F	Parental response to questions	?	Meat comes from farm animals	P. diaries & q'aires

c) Children's knowledge that milk comes from cows' udders (prevalence - 88% of children)

Table 9.5 summarises the experiences which are possible sources of the children's knowledge. 87% of the children said that milk comes from cows, in response to the picture of milk. Besides this, 88% identified the udder as the source of milk in response to the picture of a cow.

Children who witnessed the milking process directly appear to be in the minority, but some mentioned TV or video films as the sources of their knowledge. The two television programmes mentioned were *Blue Peter* and *City Slickers*. These are

children's programmes which involve a mixture of topics each week. The two video films identified were *The Fox and the Hound* and *Jack and the Beanstalk*. Despite extended and careful searching it was not possible to locate *Jack and the Beanstalk*. However, *The Fox and the Hound* is a Disney cartoon. It contains an eight-second sequence of a cow being milked by hand, including a close-up of the milk being squirted from the teats into a bucket. Some milk is then squirted directly into the fox cub's mouth and soon afterwards the bucket is knocked over, revealing its contents as the white milk spills onto the floor. Disney films were not normally shown as part of the school curriculum but were sometimes employed by lunchtime supervisors to entertain their charges during wet playtimes.

Table 9.5 Children's sources of knowledge that milk comes from cows' udders

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Observation of milking on school farm visit (Sea View, age 4)	40	Milk comes from cows' udders	Teacher (Ch. int. 2%)
1	F	Observation of milking at farm	29	Milk comes from cows' udders	P. diaries (Child int. 13%)
1	F	Observation of calf suckling at farm	1	Milk comes from cows' udders	Child int.
1	F	Repeated observation of sibling breast feeding	29	Milk is made by the body	P. diaries
2	S	Teacher explanation (ages 4 & 6)	200	Milk comes from cows	Teachers
2	S	Class library reference books (age 4 & 6)	200	Milk comes from cows	Researcher
2	F	TV/video of milking	28	Milk comes from cows' udders	Child int.
2	F	Book	3	Milk comes from cows' udders	Child int.

Unfortunately, the children were not asked whether they had seen the videos at home or at school lunch times, but in either case it is likely that they viewed it more than once.

Other, and more frequent sources of information, were teachers' explanations in the nurseries and infant classes and the picture books on view in class libraries.

d & e) Children's knowledge that salad items are grown on plants (prevalence - lettuce 49% and tomatoes 48% of children)

Table 9.6 Children's sources of knowledge that fruit and salad items are grown on plants

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Fruiting tomato plants grown from seedlings (Sea View, age 4)	40	Tomatoes grow on plants	Teacher & researcher (Ch. int. 1%)
1	S	Potatoes, onions & carrot tops sprouting on window sill Manor House, age 6)	60	Vegetables come from plants	Researcher (Ch. int. 1%)
1	F	Observed vegetables growing - family or friends' garden	40	Vegetables come from plants	Child int.
1	F	Grown vegetables personally	3	Vegetables come from plants	Child int.
1	F	Picked fruit &/or veg. in family/friends' garden	71	Fruit and veg. are grown	P. diaries
1	F	Picked wild blackberries	14	Fruit are grown	P. diaries
1	F	Picked tomatoes &/or veg. in family/friends' garden	43	Salad and veg. are grown	P. q'aires
1	F	Picked farm strawberries	21	Fruit are grown	P. q'aires
1	F	Picked wild blackberries	19	Fruit are grown	P. q'aires
2	S	Teacher explanation (age 6)	100	Fruit & vegetables grow on plants	Teacher
2	S	Class library reference books (age 4 & 6)	100	Fruit & vegetables grow on plants	Researcher
2	F	Seen vegetables growing on TV	4	Vegetables come from plants	Child int.

Table 9.6 summarises the experiences which are possible sources of the children's knowledge, relevant to both lettuce and tomatoes. It concerns seeing vegetables growing, and experiences of harvesting edible items.

Just over half the children knew that tomatoes and lettuce are grown. Information about this was provided by teachers and to be found in class reference books. Nevertheless, the source of knowledge mentioned by the children themselves (and confirmed by parents) was nearly always that of seeing these items growing and of picking edible items themselves. These direct, first-hand experiences took place in the context of family and friends. Tomatoes were the item most frequently mentioned as seen growing.

Despite the fact that tomato plants were passed every day by the twelve pupils entering Sea View nursery, and that the large green tomato fruits were pointed out to them by staff, only one child mentioned them. Similarly, only one six-year-old mentioned the onion plant sprouting in one of the infant classrooms at Manor House at the time of the interviews.

f) Children's knowledge that cheese is made from milk (prevalence - 19% of children)

Table 9.7 summarises the experiences which are possible sources of the children's knowledge.

Table 9.7 Children's sources of knowledge that cheese is made from milk

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Made cheese (age 4)	?	Cheese is made from milk	Teacher
2	F	Answered child's questions about origin of food items	?	Basic ingredients of food items	P. q'aires

Only 19% of the children, who were all among the older pupils interviewed, mentioned milk as an ingredient of cheese. Unfortunately, the children who knew this were not asked about the source of their knowledge. The only information is provided by the nursery curriculum plan. Although it states that cheese-making takes place, it does not describe its frequency. As none of the children mentioned

having this experience it could be that in fact the nursery did not make cheese on a regular basis. It seems likely that those children who expressed correct knowledge had been informed by an adult at some time, possibly in response to a question.

g) Children's knowledge that chips are made from potatoes (prevalence - 77% of children)

Table 9.8 summarises the only known experience which is a possible source of the children's knowledge. 77% of the children knew that chips are made from potatoes. Although 88% of children had seen chips being made, they were not always prepared from basic ingredients: on some occasions the chips were bought as 'oven-ready' and frozen. This is not an item that would have been cooked in school, owing to the safety hazard regarding the need for hot oil.

Table 9.8 Children's sources of knowledge that chips are made from potatoes

1/2	S/F	Type	F %	Nature of info.	Data source
1	F	Seen chips being made from potatoes	77	Chips are made from potatoes	Child int.

h) Children's knowledge that bread is made from flour (prevalence - 27% of children)

Table 9.9 summarises the experiences which are possible sources of the children's knowledge regarding the ingredients of bread. Only 27% of the children mentioned flour or cereal grains and only one child mentioned yeast.

Although the baking of bread is mentioned as an option in the nursery and infant curriculum, none of the children mentioned this experience. An explanation could be the same as that for cheese, namely that it was not in fact carried out regularly. Even when children claimed to have experienced baking either bread or cakes outside school, it is not clear how many of these occasions involved the basic ingredients from which these items were prepared, since ready-mixed packets of cake ingredients and other pre-prepared items might have been used.

Even though children did not appear to have experienced bread baking, they certainly did experience the baking of cakes and biscuits, which also have flour as

their main ingredient. Baking was experienced at school, both in the nursery and infant classes. However, the experiences most frequently mentioned by the children themselves were in the context of family and friends. According to the parent diaries, this was the only aspect of children's experience which differed according to gender. Six children (three boys and three girls) are recorded as taking part in food preparation. Two girls and one boy are recorded as doing this consistently throughout the three years, but one girl appears to have commenced cooking activities only after her fifth birthday. One boy is not recorded as taking part in cooking activities at all and two other boys only occasionally.

Books, both fiction and non-fiction, provided a secondary source of knowledge. Indeed, the ingredients of bread may have featured in children's questions.

Table 9.9 Children's sources of knowledge that bread is made from flour

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Measuring & mixing basic ingredients of bread, cakes & biscuits (age 4 & 6)	200	Bread, cakes & biscuits are made from flour etc.	Teachers & researcher
1	S	Observation of changes when baking (age 4 & 6)	200	Basic ingredients are transformed when baked	Teachers & researcher
1	F	Made bread personally	2	Bread is made from flour etc.	Child int.
1	F	Cooked items personally	86	Basic ingredients are transformed when baked	P. diaries
2	S	Class library fiction books describing bread making e.g. <i>'The Little Red Hen'</i>	100	Bread is made from wheat which is ground into flour	Teachers & researcher
2	F	Answered child's questions about origin of food items	200	Basic ingredients of food items	P. diaries
2	F	Answered child's questions about origin of food items	10	Basic ingredients of food items	P. q'aires

i) Corn flakes are made from corn (prevalence - 43% of children)

Although 43% of the children mentioned corn or wheat as the main ingredient of corn flakes, very little information was available in relation to experiences the children might have had which could be a source of their knowledge. When asked, 23% of the children admitted that they had guessed this from the name. Only one child mentioned an advertisement as the source of her knowledge. This may have been the case with other children as well, as shown in table 9.10.

Table 9.10 Children's sources of knowledge that corn flakes are made from corn

1/2	S/F	Type	F %	Nature of info.	Data source
2	child	Guessed from the name	23	Corn flakes are made from corn	Child int.
2	F	Seen picture of corn on packet	?	Corn flakes are made from corn	Child int.

j) Children's knowledge that hens eat grain, crusts, vegetation, worms, etc. (prevalence - 71% of children)

Table 9.11 summarises the experiences which are possible sources of the children's knowledge. 71% mentioned suitable items. No children at Sea View nursery claimed to have had this experience at school, even though the quail chicks could be observed pecking at their food and pupils took part in their care.

As mentioned above, a nursery visit was organised to a local working farm in the summer term. However, only half the pupils at Sea View nursery recalled the school visit even though it was a recent event, whereas one third of the older children remembered that they had taken part in a school visit in the past. The pupils of Manor House nursery had not yet been taken to the farm at the time of the interview.

Despite the availability of secondary information in the form of school books, first-hand experiences featured largely in children's own attribution of their knowledge. These included the feeding of wild birds as well as feeding hens.

Table 9.11 Children's sources of knowledge about food for hens

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Observed quail chicks being fed	40	Birds eat grain,	Researcher
1	F	Observed hens being fed at farm	9	Hens eat grain etc.	Child int.
1	F	Fed hens personally	7	Hens eat grain etc.	Child int.
1	F	Fed garden birds	11	Birds eat crusts, worms, etc.	Child int.
2	S	Class reference & library fiction books describing hens feeding	200	Hens eat grain, crusts, vegetation, worms, etc.	Researcher
2	F	Saw hens feeding - TV/video	6	Hens eat grain, crusts, vegetation, worms, etc.	Child int.
2	F	Parent explanation	2	Hens eat grain, crusts, vegetation, worms, etc.	Child int.

k) Children's sources of knowledge that cows eat grass (prevalence - 93% of children)

This was the most well-known item in the study. 93% of the children mentioned grass and other vegetable matter as suitable food for cows. These were the animals most frequently to be seen in the farmers' fields nearest to the localities of Sea View and Manor House. Children's opportunities for seeing farm animals (whose main activity is feeding) are shown in table 9.12.

At the time that the semi-structured interviews took place the pupils at Manor House had not yet experienced their farm visit. Therefore, the eighteen pupils interviewed at Manor House nursery did not refer to it although several older children

remembered visiting the farm. On the other hand, the children at Sea View nursery had recently visited the same farm and six (half of them) said so in the interviews.

Table 9.12 Children's sources of knowledge that cows eat grass

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Farm visit (age 4 & 6)	200	Seen farm animals feeding	Teachers & researcher (Ch. int. 30%)
1	F	Farm visit	52	Seen farm animals feeding	Child int.
1	F	Farm visit(s)	100	Seen farm animals feeding	P. diaries
1	F	Family walks through fields	26	Seen farm animals feeding	P. q'aires
1	F	Theme park etc. visits	48	Seen animals feeding	P. q'aires
1	F	Farm visit(s)	36	Seen farm animals feeding	P. q'aires

The nursery book corner had on display a collection of books about farm animals at the time of the farm visit. The staff read these books with the children and explained how food was produced on the farm.

l - o) Children's knowledge about the needs of plants (prevalence - water 89%, soil 37%, sunshine 37% and fertilizer 7% of children)

Table 9.13 summarises the experiences which are possible sources of the children's knowledge about the needs of plants. The most common fact known to the children (89% of them) was that plants need water. As plants need to be watered regularly, it is likely that the children were involved in doing this on numerous occasions. Furthermore, their experiences would not have been limited to school. Involvement in the care of plants was mentioned frequently in the context of family and friends as well.

37% of children knew that plants need soil. They must have seen plants growing in soil, and they used soil-based compost when planting seeds in the nursery. Nevertheless, children would not have been directly involved in providing soil for plants on a regular basis in the way they were in watering them. 37% of children mentioned that plants need sunshine. It seems likely that the need to place plant pots on a window sill was the source of that knowledge.

7% of children knew that plants need fertilizer. It seems likely that the source of their knowledge was that they had helped to water plants with mineral solution.

Table 9.13 Children's sources of knowledge about the needs of plants

1/2	S/F	Type	F %	Nature of info.	Data source
1	S	Plant seeds & water them (age 4 & 6)	60	Plants need soil & water	Teacher & researcher
1	S	Plant tomato seedlings & water them (Sea View, age 4)	40	Plants need soil & water	Teacher
1	S	Water seedlings with 'plant food', i.e. fertilizer (Sea View, age 4)	40	Plants need fertilizer	Teacher
1	S	Water sprouting vegetables (Manor House, age 6)	60	Plants need water	Researcher
1	S	Carry out experiment showing that plants need water, soil & light (age 6)	100	Plants need soil, water & light	Teacher
1	F	Plant seeds & water them	57	Plants need soil & water	P. diaries
1	F	Care for garden plants	71	Plants need soil & water	P. diaries
1	F	Water seedlings &/or garden plants	71	Plants need soil & water	P. q'aires
1	F	Make compost heap	7	Plants decompose to enrich the soil	P. diaries

9.5. Children's attribution of the sources of their knowledge

The children themselves most often attributed experiences outside school as the sources of their knowledge. In fact, they appeared to ignore many of the opportunities they had in school. It is especially remarkable that so many of the pupils at Sea View nursery omitted to mention their experiences with chicks and tomatoes which were on-going at the time the semi-structured interviews took place.

One explanation, as explained in chapter six, is that there are developmental reasons why young children do not share with a questioner all that they know. It is also noted in chapter seven that Gopnik and Graf (1988) identify a difficulty three-year-old children have in saying how they know something. This problem might have affected the four-year-olds in the study as well. Other possible reasons, indicated in a comparison of school- and home-based cooking experiences are discussed below. However, the question that still remains is why so many children mentioned family-based rather than school-based experiences. If children simply wished to please the questioner, then it would be expected that they would first mention school-related experiences since they were being questioned in school.

Direct, first-hand experiences

A comparison of experiences in the two settings shows that direct, first-hand experiences took place in both. Those which were similar in both school and family settings include visits to farms, caring for plants and experience of cooking. However, a difference between the two settings is that whereas a particular experience (for example a farm visit), was offered only once or twice in the school setting, it was repeated several times by some of the families.

Secondary sources of information

Although few children of any age referred to verbal input by an adult as the source of their knowledge, it is clear from parental reports that in the family setting nearly all of them asked many questions in an attempt to satisfy their curiosity and to make their own mental links among experiences of different kinds. Factual information, including the origin of food items, featured frequently. Questions about food occurred most frequently when meals were eaten together as a family, a finding in accordance with that of Tizard and Hughes (1984), mentioned in chapter seven. In contrast, in the taped cooking episode at least, children's opportunity to ask questions in school was limited by the number of children (sixteen at a time) working with one teacher.

An important finding from the questionnaires is that children watched their favourite recorded programmes and films many times. This can be contrasted with the practice in schools, where video recordings were normally shown only once.

At home, computers did not feature as a source of information for these young children and were not mentioned in connection with information about food by teachers.

Books were rarely mentioned by either parents or children. At school, on the other hand, books were available for pupils to choose and were much used by the teachers.

Other contributory factors

To be sure, one explanation is that children did indeed learn more in informal settings. Whereas the information on offer in school was more structured, the informal learning opportunities offered by family and friends may have been more easily assimilated. Five contributory factors can be identified:

- a) The adult/child ratio and the exercise of control,
- b) The quality of the conversational exchange,
- c) Involvement in direct, first-hand experiences,
- d) The purpose of the activity,
- e) Making mental links between home and school,
- f) Recall of knowledge and promotion of mental links among items.

A comparison of the children's experience in the two settings is illustrated by the tape-recorded nursery and home cooking sequences. The transcripts were subject to discourse analysis in a search for evidence of these factors.

a) The adult/child ratio and the exercise of control

The better adult/child ratio is obvious, since there were sixteen children with one teacher in the nursery but a one-to-one relationship in the home cooking episodes. This means that in the family context, children did not have to meet the behavioural expectations of the teacher at the same time as trying to maintain a conversational exchange.

The nursery teacher had to regulate the behaviour of her pupils. She did this at the beginning of the cooking session by gaining their attention and making a detailed request for recall of the hygiene procedure enacted on previous occasions:

T. Now, are you listening? Are you looking at me? What do you have to do before you do any cooking at all? Before you do any cooking?

C. You have to pull your sleeves up.

T. That's one thing. There's something else. Something else that's very, very important.

C. I've got short ones!

C. I've got long ones!

T. Listen. Listen. Stephanie! Are you listening? What would happen if you made biscuits and you had just been out playing in the garden and then just came in and then you just came in, and made the biscuits?

C. Muck.

T. So what do we have to do?

C. Wash them!

Analysis of the home cooking episodes reveals a different relationship between adult and child from that evidenced in the nursery. As in the nursery, Emily's mother began the session with an exchange about hygiene. However, whereas the teacher in the nursery used the necessity for hygiene as an opportunity to assert her authority, the child asserted herself in the home environment, claiming her own prior knowledge:

M. Are you going to wash your paws?

E. They're dry. They're OK.

M. Yeah, I know. But you're supposed to wash them, aren't you, before we start to make something?

E. I know how.

In fact, the two parents made more statements directed at behaviour management (usually in connection with the children's wish to eat the uncooked ingredients) than the teacher did. This finding confirms that of Tunnicliffe and her colleagues (1997), who found that there was a higher management component in the family conversations on a visit to the zoo than there were in the teacher-pupil interactions.

b) The quality of the conversational exchange

Unlike the situation in the nursery, many adult-child exchanges at home lasted for considerably more than two turns each. This indicates a more profound interpersonal engagement.

In both settings the children asked relevant questions but this happened on only two occasions in the nursery, whereas Daniel asked thirteen questions and Emily twenty-six. Both in the nursery and home cooking sessions children were asked questions

related to the task and could give appropriate responses. More obvious is that, whereas the teacher's utterances were lengthy and detailed, most individual children's utterances were comprised of only one or two words. Furthermore, whereas the teacher gave instructions or commands, the children responded with actions rather than words. Whereas in the nursery the initiative for talk was with the teacher, many home-based exchanges in the home were initiated by the children.

Perhaps the most striking aspect of the recorded home cooking events is that at home the children, especially Emily, were able to engage in extended conversation including diversions, jokes and reminiscences similar to those mentioned by Solomon (1994). In addition, the mothers were able to scaffold their children's thinking by helping them to express their meaning and following through some of the implications of what they said. This confirms Tizard and Hughes' (1984) finding, mentioned in chapter seven.

c) Involvement in direct, first-hand experiences

In both cases the adults provided role models and explanations of how to carry out tasks but in the school cooking session it was necessary for children to take turns and to wait for assistance. This precluded the opportunity to receive the individual help and advice which was available at home. For example, Emily engaged in a prolonged exchange about the process of weighing, involving twenty-one turns each between mother and child.

On the other hand, although the children in both settings were encouraged to use their senses to make observations, this was far more evident in the nursery. For example, it took place on thirty-five occasions in the nursery but on only ten during Emily's session and six during the session with Daniel.

d) The purpose of the activity

Whereas at school there were clear, stated learning objectives relating to the development of descriptive language, at home the objective was the production of the food.

e) Making mental links between home and school

Contrary to the description of adult-child exchanges in a nursery setting mentioned in chapter seven by Tizard and Hughes (1984), the teacher at Manor House referred to children's home experiences on seven occasions. Nevertheless, three were directed to Christopher, whose mother the day before had brought in home-made jam tarts for the teachers to eat at break time.

Altogether, Emily initiated three exchanges which were irrelevant to the task in hand. Two concerned the story of how she hurt her knee while playing in the nursery paddling pool. In this way she engaged her mother in a mental connection with her life at school. Between mother and child, nine references were made to the nursery altogether: two more links than were made in total at the nursery cooking session to the homes of all the pupils who took part.

f) Recall of knowledge and promotion of mental links among items

In both nursery and homes the children were encouraged to recall relevant procedural knowledge during a cooking episode. The example of the need for children to wash their hands has already been mentioned. However, the recall of prior knowledge in the home sessions referred to rich, shared experiences with the parent or with other close family members and was conducive to the development of understanding. For example, Emily had picked gooseberries herself, and so was aware that they grow on bushes. This was apparent when her mother helped her to make a mental connection between a statement that gooseberries taste sour and her own experience of eating raw fruit straight from the bush. Similarly, in trying to help him understand a food chain, Daniel's mother encouraged him to make a mental link between the chicken he ate for dinner and his experience of seeing his uncle feed chickens.

These examples (taken from the cooking transcripts) show how, because of their intimate knowledge of individual children, family members can better help children to make mental links among factual items and personal, direct experiences which are meaningful for them. In this way, the findings confirm those of Dierking and Falk, (1994) and Tunnicliffe and her colleagues (1997), mentioned in chapter seven, that families assist children in making mental connections in terms of the child's prior knowledge and experience.

Finally, the parent diaries and questionnaires provide detailed evidence that the children had endless opportunities to ask questions and receive detailed answers from family members and friends. In contrast, the difference in the adult/child ratio at school severely restricted children's opportunities. This confirms Tizard and Hughes' (1984) impression that children learned a good deal by being with their mothers and asking questions.

9.6 Reliability and validity of the data

In this section, the reliability and validity of the data is discussed by comparing information from different data sources: the children, the parents from the two localities, and the teachers.

9.6.1 Statements from children

In a comparison of different age groups it can be seen that the older pupils were sometimes better able to recall key experiences from their nursery days (for example, a farm visit) than were the nursery pupils themselves. However, overall the experiences mentioned by children of all ages were similar. Confirmation of many of these experiences is provided by the statements of adults. Nevertheless, the experiences mentioned by those pupils whose parents did not provide information of any kind cannot be confirmed by triangulation. In fact, examination of the instruments employed by Wells (1980), Tizard and Hughes (1984) and Flewitt (2002) indicates that, even if access to these homes could be negotiated, further study of these topics would be difficult and time-consuming due to their unforeseen nature and so outside the possibilities of the present study. However, as it is likely that the parents who responded had a higher literacy competence than those who did not, this weakness imposes a limit on the generalisability of the findings. A way to test this hypothesis in the future would be to ask all the parents of the children who were interviewed to complete questionnaires and/or diaries. After this, it would be possible to divide the children onto two groups: those whose parents provided information and those whose parents did not. Then the experiences claimed by the two groups of children could be analysed for similarities and differences.

9.6.2 Family-based experiences at Sea View and Manor House

The evidence presented in this chapter shows both similarities and differences between the informal experiences of children at Manor House and Sea View.

i) First-hand experiences

Similar first-hand experiences were recorded at both locations. Both gave accounts of hobbies and treats. They described visits to farms, caring for plants, and cooking opportunities with family members. However, no doubt as a reflection of the financial limitations experienced by families at Sea View, the journeys described there were more often by bicycle or on foot than by car, and involved shorter distances than those taken by Manor House children.

ii) Conversation and the media

The questionnaires and diaries completed by parents show that the children at both locations asked a large number of questions and that food origins featured in each. Children in both locations had plenty of access to television programmes and video films. However, the children at Manor House whose parents kept diaries, made more mention of educational programmes such as *Art Attack* and *Blue Peter* than did the parents at Sea View who completed questionnaires. Details of the Disney video films mentioned in the parent diaries were not forthcoming but, as reported above, *The Fox and Hound* and *Jack and the Beanstalk* are both Disney films which were identified by children in the semi-structured interviews as a source of knowledge about cows being milked. *Blue Peter*, the television programme most frequently mentioned in the parent diaries, together with *City Slickers*, were identified by children in the semi-structured interviews as sources of their knowledge. However, none of these television programmes or video films was specifically mentioned in the Sea View parent questionnaires.

Information provided by parents

An important limitation on the value of this source of information is the small sample size both of the parents who completed the questionnaires and of the parent diary-keepers. Nevertheless, they support both each other and the data provided by the children. The diaries, in particular, confirm that informal experiences were not limited to those offered by parents. Child minders, family friends, neighbours and relatives all contributed to the children's experiences. Grandparents, especially, featured frequently in accounts of informal learning, especially in relation to cooking and gardening.

9.6.3 School-based experiences

Apart from the researcher's participant observation of the nursery cooking and farm visit, and the familiarisation time spent with each class prior to the semi-structured interviews, it was not possible to discover the way in which food-related topics were taught, or indeed to check whether the items listed in curriculum plans took place as often as indicated. Notably (in view of the younger children's ignorance its origin), it seems doubtful that cheese was made often enough in the nursery for all the four-year-old children to be involved with it. Be that as it may, it seems likely that much of the children's knowledge was acquired in school.

9.7 Discussion and conclusion

A prediction based upon the work of developmentalists such as Piaget might be that children will learn best from direct, first-hand experiences. Further, if the accounts of the children themselves are to be accepted, the informal experiences they encountered (with family and friends) will emerge as being more important than school-based experiences. In an attempt to discover whether these two predictions are correct, the findings reported in this chapter are summarised in table 9.14.

Table 9.14 Summary of the sources of children's ideas in order of prevalence

Children's ideas	Prevalence of idea	Main sources of information	1/2	S/F
Cows eat grass	93%	Seen eating	1	S & F
Plants need water	89%	Watered plants	1	S & F
Milk comes from cows' udders	87%	Video	2	F
Eggs come from hens	83%	Teacher explanation	2	S
Chips are made from potatoes	77%	Seen cooking	1	F
Meat comes from animals	66%	Adult explanation	2	S & F
Lettuce and tomatoes are grown	49% 48%	Seen growing	1	F
Corn flakes are made from corn	43%	Children's guess	2	?
Plants need soil	37%	Planted seeds	1	S & F
Plants need sunshine	37%	Cared for seedlings	1	S & F
Bread is made from flour	27%	Seen baking	1	S & F
Cheese is made from milk	19%	Adult explanation	2	S & F
Plants need fertilizer	7%	Cared for plants	1	S & F

Here, the children's ideas are presented in the order of their prevalence. In each case, the presumed main source of knowledge is itemised. Then an indication is provided of whether the experience was a direct or secondary one. The final column indicates whether the experience took place in school-based work or with family and friends.

This table indicates that direct, first-hand experiences account for more knowledge than secondary ones, but that in the case of the origin of milk, video films (even in the form of cartoons) provide an adequate substitute for direct observation. It seems that school alone is uncommon as providing the main source of knowledge, and that family and friends alone are not the most frequent providers either. It appears that in most cases knowledge is the result of experiences which have occurred in both settings. Indeed, this last point can be related to the fact that the most prevalent of children's ideas (that cows eat grass, that plants need water and that milk comes from cows' udders) were those which involved several opportunities for learning.

The purpose of this chapter is to account for the large amount of correct knowledge that children had (as reported in chapter six). With the exception of adults' use of the term *plant food* for mineral solution, no incorrect information appeared to be extended to the children. Even when children could have been misled by commercial food names such as *turkey aeroplanes*, they did not develop a misconception as a result.

The conclusion to be reached as a result of this empirical work is that, granted the acknowledged limitations of access to data and the uncertainties regarding the validity and reliability inherent in studies of this kind, an account can be given of the opportunities young children had to learn about the organic origin of food both at school and in the context of the family. In particular, it emphasises the importance of informal, family-based experiences in providing experiences which can work together with school studies to promote learning in young children. In fact, such a conclusion resonates with the research reviewed in chapter seven.

PART FOUR: CONCLUSION OF THE THESIS

CHAPTER TEN

CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

The purpose of this final chapter is to bring together the different dimensions of the research and to explore the relationships among them. It provides the opportunity to coordinate and systematise all the discoveries which have been made, both theoretical and empirical, relating to the development of the scientific concept, the organic origin of food. In doing so, it is possible to clarify some aspects of early learning in science which have not previously been brought to the attention of early years educators. As a consequence it is possible to make some suggestions for more effective science teaching.

This chapter also provides the occasion for acknowledging those aspects of the work which, with hindsight, could have been better. It provides opportunity for reflection: to decide what aspects of the topic require clarification and those which deserve further study.

10.2 Outline

First, the findings of the two empirical parts of the thesis are brought together in order to clarify the relationship between children's developing knowledge and understanding and their opportunities for learning. Then there is a discussion of the misleading statements that young children make and early evidence of a misconception in science. Following this, the implications of the work for educators are identified and recommendations made. Finally, the project as a whole is evaluated.

10.3 The development of factual knowledge

The empirical part of the project indicates that by the age of four children already demonstrated an impressive amount of factual knowledge relating to the origin of food items. Moreover, by the age of eight children evinced a significant increase in that knowledge.

Frequently, it seems that at the time they were questioned about an item of knowledge children could not remember how they learned about it. However, the source of this burgeoning knowledge appears to be found first and foremost in children's practical experiences both at school and with families and friends, rather than in books or computers. Thus the finding that children knew that growing plants need water, soil and sunshine can be attributed to their own experience of planting seeds and caring for seedlings. Similarly, the finding that most children knew that lettuce and tomatoes grow on plants can be matched with their experience of seeing these items growing. Their knowledge that cows eat grass, and that chips are made from potatoes which are covered in soil and have to be peeled, doubtless originated from the repeated observations which were mentioned in part three of the thesis. In some cases it appears that video film has been a worthy substitute for experience, so that whereas the process of milking was seen in real life by only a few, several children were confident in their knowledge of this process as a result of watching Disney films.

However, it is unlikely that other items of knowledge were gained through either direct experience or videos. Instead they appear to be the result of extrapolation from a combination of associated experiences and explanations. Thus children's knowledge that meat comes from animals cannot be explained in terms of visits to an abattoir but instead to a mental association between its appearance in uncooked state in shops and their kitchens at home on the one hand, and the outcome of the many questions children asked about the origin of such things on the other. Only one child is recorded as seeing an animal, a fish, being killed and cooked for her to eat. Furthermore, even the farmers who keep them cannot directly observe hens laying eggs since they do so in secluded nests. Visual images (drawings, photographs and videos) of both hens and eggs, together with adult explanations appear to be the source of this knowledge which was demonstrated by many.

Evidence for children's ability to transfer their knowledge from one context to another has already been noted in relation to children's statements about suitable food for hens because although a few of the children had direct experience of seeing them being fed or feeding them personally, others reasoned that since wild or pet birds ate seeds, bread and worms, hens would do so as well.

It seems remarkable that so many children exhibited knowledge of corn and wheat as little grains or seeds as these items are not commonly available for examination. A few could even say that wheat is brown and grows on long stalks and that corn is yellow. Of course, some might have experienced cereal grains directly but for others

who knew about such things the opportunities must surely have been limited. It can be conjectured that traditional story books such as that of *The Little Red Hen*, which describes with the aid of illustrations the whole process of producing a loaf of bread from planting grains of wheat, through harvesting, milling and baking, might have provided the information.

Despite having a knowledge of cereals, however, details of baking bread and its ingredients were unknown to many. This was the case even though, if they had not baked bread, they had at least experienced baking cakes at school. This lack of knowledge appears to verify the assumptions of the teachers, that modern children do not have much experience of the preparation of foods from basic ingredients at home. The main ingredient of cheese was unknown to all except a few of the older children interviewed, regardless of the statement in the nursery curriculum plans that children would take part in cheese making. It could be that these two findings indicate that a single experience was insufficient for sound learning to occur, suggesting the need for repeated experiences by way of reinforcement. On the other hand, it could be an example of the idea, suggested by Gellert (1962: 391), and mentioned in chapter four, that "only selected facts were assimilated from among those that presumably were available to the children". Finally, it could be that this aspect of curriculum planning had not been implemented.

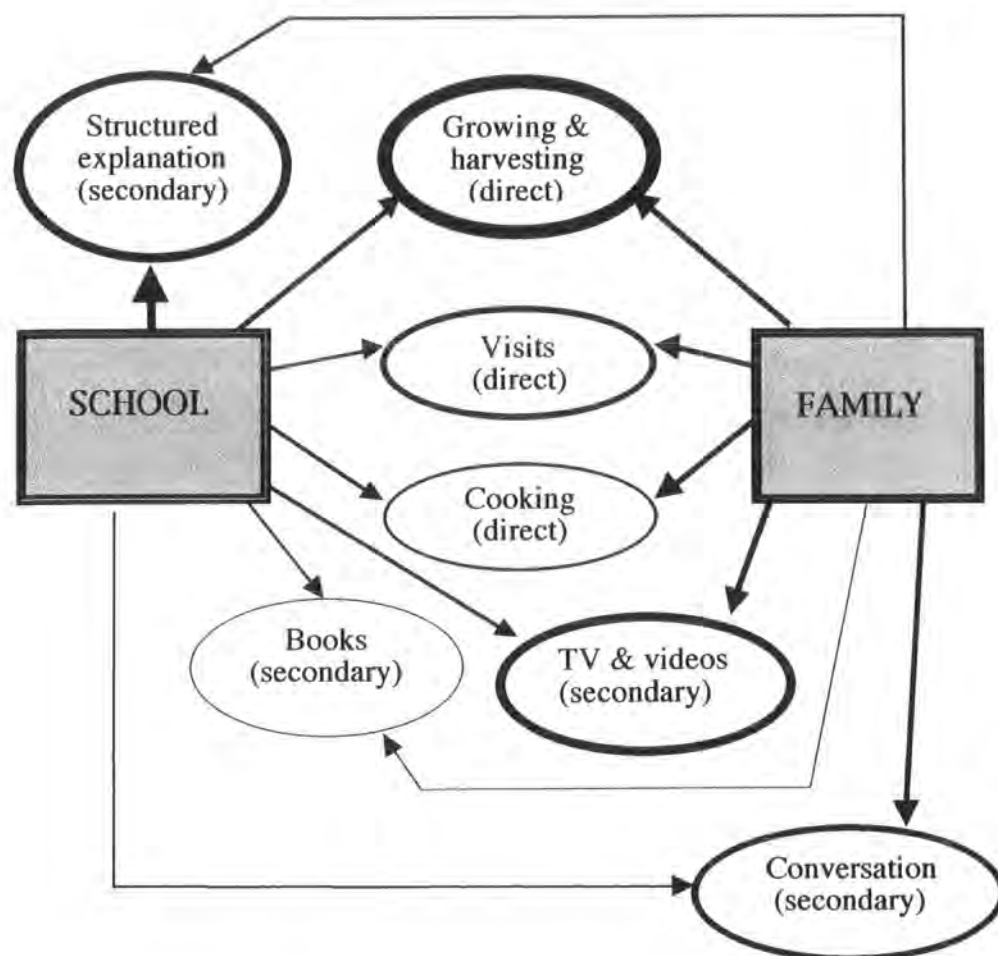
Clearly, young children valued the experiences they had outside school which contributed to their learning. They frequently recalled them first, omitting to mention experiences they had in school. However, the sources of several items of the knowledge children held is still in part a matter for conjecture. Therefore, further evidence in the form of focused questioning is required from children, parents and teachers in order to clarify these issues.

An account of learning in young children would not be complete without recognition of their innate desire for information. This boundless curiosity is evidenced in the present study by the many questions children asked their parents. Their questions appeared to be in response to the stimulus of the immediate environment and also the result of children's inner thoughts which were sometimes sustained over long periods of time.

A summary of the sources of children's knowledge is presented in diagrammatic form in figure 10.1. The importance of the different components of the opportunities for learning is indicated by the thickness of the ellipse surrounding it. The strength

of the contribution made by school and family is indicated by the thickness of the arrow leading from the source to the component.

Figure 10.1 The sources of children's knowledge



Overall, the empirical enquiry provides confirmation of the hypothetical suggestions put forward in the literature reviewed in chapter four. In particular, it provides details of both the first hand experiences and the secondary sources that were expected to provide the basis of the children's knowledge. However, the data show the importance of informal experiences for the development of correct ideas, rather than the misconceptions for which they have been censured in the literature. Indeed, apart from the commonly used term, *plant food*, for the mineral solution provided for tomato plants, and the misleading commercial names for food products (such as *turkey aeroplanes*), no examples of incorrect information were found.

10.4 The development of understanding

As explained in the second part of this thesis, demonstration of the understanding that people are all dependent either directly or indirectly upon plants for their food did not show a significant correlation with the amount of factual knowledge held. This was the case even though the procedure of the semi-structured interviews amounted to a presentation of factual items which could have led the respondent to this understanding by the final question.

Psychologists who hold a process view of learning might explain this lack of understanding simply as an inability to make the necessary mental connections. Post-Piagetian researchers, on the other hand, might explain this lack of insight in terms of the underlying theories children hold.

Although the children themselves did not refer to the fact, parental reports indicate that almost all the children asked many questions in order to increase their factual knowledge relating to items already known. By asking questions so frequently they indicated attempts to make mental connections among the items of knowledge they possessed and so develop understanding.

10.5 Misleading statements in young children

There are several ways in which adults can be misled by the responses of young children. Whereas statistically significant findings indicate that children's factual knowledge increased with age, the youngest children (many of those aged four years and some aged six) could not state all their knowledge at any one time and so could mislead adults into thinking they knew very little. This was the case even when they were encouraged to indicate more knowledge and given extra memory cues.

Adults can also be misled by those statements given by the youngest children which would be surprising if given by older ones. A detailed analysis of the puzzling statements of young children identified in the semi-structured interviews is provided in chapter six. It reveals that there are several different types of such responses, and a suggested explanation for each is provided. Most importantly, it appears that many of these intriguing statements are not the result of a young child's inability to understand the question put to them through limitations of vocabulary or comprehension. Neither are many of them the result of linguistic limitations in producing an appropriate response. Instead, recent work in developmental cognitive neuroscience can be applied to their interpretation. It appears that many of these

intriguing statements are the result of developmental effects on the mental processing of information. Firstly, children's capacity for holding items in working memory is limited. Secondly, they may be unable to inhibit inappropriate mental connections between knowledge items. Thirdly, younger children may categorise items differently from older children. Fourthly, young children may experience difficulty in inhibiting inappropriate mental connections. Fifthly, they may not be able to switch from one line of thought to another. These developmental differences cause them to respond to questions in intriguing ways.

10.6 The development of a misconception

Taking into account the difficulties inherent in the interpretation of the statements of young children, it is not surprising that the first signs of a fundamental misconception have received scant attention in the literature. It is clearly noted that older children consider only water, minerals and sunshine as necessary for plant growth, omitting to mention the need for carbon dioxide. However, the fact that pupils as young as four, six and eight years of age do so as well has received little comment. Unlike the intriguing statements discussed in the previous section, this finding has not been considered surprising, since it appears to indicate simply a childish limitation of knowledge which will be rectified over time.

However, the important point is that these responses are reported by Leach and his colleagues (1992) to be crucial in teenagers who find the process of photosynthesis counterintuitive. It is suggested in this thesis that unconscious, or implicit, learning from sensory experiences is both the origin of this misconception and the reason why it is so difficult to change.

10.7 Recommendations for educators

Several findings in this study have relevance for those concerned with the education of young children.

Firstly, they provide much confirmation of the popular belief among early years specialists who base their thinking upon Piaget's theory of cognitive development. Here, the first two stages (*sensori-motor* and *pre-operational*) involve the senses rather than mental actions. It appears that teachers are most likely to be effective when they provide a learning environment which is rich in sensory experiences. However, according to the evidence provided in chapter nine, it seems that visual images such as pictures, photographs and video films play an important part in the

learning of young children. Furthermore, although the explanations of adults are mentioned only occasionally by the children, verbal responses to children's frequent questions were presumably effective in promoting learning.

Secondly, if the developmental explanations provided in this thesis are accepted, then educators need to understand that young children cannot always process their thoughts in the same way as adults, even though their statements frequently demonstrate logical thought. An important finding recorded in chapter six is that they find it difficult to tell their teachers all that they know or have experienced. Absence of this insight can have two unwelcome consequences. It can lead teachers to underestimate children's knowledge and consequently to provide insufficient challenge for them in school. It can also prevent teachers from appreciating the rich learning experiences many children have outside school so that they are not capitalised in class. If teachers were aware of the full extent of children's knowledge they would be better able to help them. This is especially the case regarding help in the construction of those mental links among items of knowledge which appear to be of crucial importance in the development of understanding.

Thirdly, educators need to be aware that the foundation for certain key misconceptions in science might have already been laid by the time young children start school. It is suggested here that early intervention is likely to be the most effective, since evidence has been presented in chapter three that the brain has a higher degree of plasticity in young children than in older learners and are therefore less resistant to change.

With regard to these early signs of misconceptions, a way forward can be suggested in terms of helping learners to translate their implicit knowledge into linguistic form. Children could be helped by providing verbal commentary alongside sensory experiences which might otherwise go unnoticed. This could be done by keying into those sensory experiences that are not normally verbalised as they happen. The example of children's awareness of the need of plants for water but not of air or light is a case in point. Children already have many experiences of talk with adults as they water plants. They also experience talk as they observe the way plants recover from wilting within a short time after receiving the water. However, it is possible to provide a verbal commentary for them when experiencing the air (for example when flying a kite), which is normally felt by large areas of the skin rather than the fingertips. It is also possible to provide a verbal commentary when experiencing sunlight, which could be described as a form of energy (for example, that it can produce a reading on a light meter or that it can activate a solar panel

connected to a motor), rather than simply as a visual experience which promotes a general feeling of well-being. The effectiveness of these strategies for promoting explicit awareness of the importance for plants of light and air could be tested through experimenting with intervention and control groups of children.

10.8 Evaluation of the project

Evaluation of the project as a whole involves reservations with regard to the reliability and validity of the data.

Firstly, due to the opportunistic sampling that was employed, caution should be exercised in the generalisation of these findings. This means that the children who were the subjects of this investigation were not chosen through random sampling of the population. For example, the lack of ethnic mix in the schools and their environments suggests that they cannot be representative of schools in other parts of the country where pupils have many different ethnic origins. Nevertheless, they may resemble in certain combinations the characteristics of other cases elsewhere sufficiently to provide fresh insights for those interested in the education of young children.

Another reservation regarding the sampling is that, although the information provided by parents has illuminated many points which do not appear in the literature, it provides only a snapshot of the environment children experience outside school. Moreover, the parents who provided the information did not truly represent the families of all the children who took part in the semi-structured interviews, since it is likely that the most literate parents are those who have kept diaries and returned questionnaires. Therefore the nature of the experiences on offer in the homes which are not represented remains an open question.

Reservations must be expressed with regard to the research instruments. For example, it is acknowledged that a more experienced researcher might have been able to elicit more detailed responses from the children who took part in the semi-structured interviews. Certainly, any further replications carried out by this researcher would have the advantage of hindsight in refining the research instruments. The main obstacle in analysing the data has been that, in an attempt to emulate Piaget's clinical interview, the researcher did not follow a schedule which was exactly the same for each child. This had the result that the level of support provided in probing children's knowledge was not the same for each individual. A

further pitfall brought about by the imprecise schedule has been that some children were not asked how they knew key information.

The final interview question, relating to children's understanding that ultimately we all depend upon plants for our food, was unsatisfactory in that it did not elicit responses that were sufficiently detailed. A better strategy would have been to provide the children with the opportunity to create a concept map. This could employ White and Gunstone's (1992) suggestion for probing understanding in young children, using a set of picture cards and arrows rather than the paper and pencil task described by Novak and Gowin (1984). The cards could be smaller versions of the pictures already used in the interview together with a few others, such as pictures of a watering can, the sun, some grass in close up, a head of wheat with the grains illustrated, and a person. Then the child could have worked with the researcher. Starting with the person and working through the human food pyramid, the child could reach the conclusion that we all depend upon plants. The map itself and the discussion accompanying it could be expected to provide a rich source of data about the child's understanding.

Another difficulty in drawing conclusions from the findings is that an argument has been made for the idea that children cannot tell an investigator all that they know, due to the limitations in mental processing which have been identified. A further problem is that any implicit knowledge children may have about the material world cannot, by definition, be expressed explicitly in words at all (although, as Karmiloff-Smith suggests, some of this knowledge might be translated into explicit form as development proceeds). Therefore any conclusions drawn must be regarded as provisional.

Notwithstanding all these reservations it has been possible to draw some positive conclusions. It was stated in the introduction to this thesis that the project was intended as an exploration and that the findings would lead to some testable hypotheses. It is clear that some fresh insights have indeed been gained as a result of the study. What is more, the discussion in chapters six and nine as well as in this chapter include the formulation of a total of ten ideas for further study.

This thesis ends with a personal note. In the case of the present author, thirty years elapsed between gaining a science degree and beginning postgraduate study. The experience of returning after such an interval can be likened to that of a time traveller who notes with wonder the advances made. However, a new environment can be threatening too. In thirty years word meanings shift and change, resulting in

misunderstanding and confusion. The use of new technology and statistical analysis for the first time posed challenges as well. With such demands, the years spent raising a family single-handed and experience of headship in three different schools seemed to count for little.

The reward has been the fulfilment of an enduring ambition: to discover and apply the findings of psychology to an educational issue. A further and unanticipated delight has been the introduction to an international research community. The completion of this thesis is therefore not the end of a project so much as the beginning of an extended commitment to research.

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APPENDIX I: INITIAL LETTER TO PARENTS

Manor House Nursery

Dear Parents,

I am a research student at the University of Durham, finding out about children's learning in science. I need some volunteer parents to keep a record of what their child is learning when they are with their family. If you are interested in helping, will you please come to a short meeting 20 minutes before the end of the session on Tuesday next. I will explain more about the project and answer questions at the meeting.

Yours sincerely,

Jenny Cumming

APPENDIX II: EXAMPLES OF SEMI-STRUCTURED CHILD INTERVIEW TYPESCRIPTS

Sea View Nursery Interviewee: S. A. Age four years

1. R. S**** A****, isn't it?
2. S. Mm mm.
3. R. Right, now here's the first picture. There's some eggs frying in the pan.
4. S. We have eggs for, on the morning sometimes.
5. R. Do you?
6. S. Yes.
7. R. Do you like them fried?
8. S. Yes. Do you know what? Daddy taped my Robin Hood.
9. R. Did he?
10. S. And we going to [indistinct] Robin [indistinct], Robin Hood.
11. R. Oh right. Do you like eggs cooked any other way?
12. S. Yes.
13. R. Besides fried?
14. S. I like eggs. We have ... we have a boiled egg.
15. R. Oh right, they're nice aren't they?
16. S. And a egg cup .. in a egg cup.
17. R. That's nice, yes.
18. S. Mm mm.
19. R. Do you help your mum get any food ready in the kitchen?
20. S. No.
21. R. No.
22. S. We play.
23. R. You play while your mam
24. S. Yes.
25. R. ... does the cooking.
26. S. We have loads of toys.
27. R. Oh well, you are lucky aren't you?
28. S. And we've got loads of videos, Mam's got loads of videos.
29. R. Oh right. There are the eggs.
30. S. Yes, and erm, and we had The Lion King on.
31. R. Did you?
32. S. Mm mm.
33. R. There are the egg shells.
34. S. Just when we .. just first .. when we just got up, and it takes a long time and when we went to go it was still on.
35. R. Was it?
36. S. Yes.
37. R. It was a long one so you'll see the rest another time, won't you?
38. S. Mm mm.
39. R. There are the egg shells from those two eggs
40. S. Mm mm.
41. R. From those two eggs. There are some more in the box. Can you tell me where eggs come from?
42. S. From ... don't know.
43. R. I think you do.
44. S. From .. egg shells.
45. R. Right, but where do the eggs, the whole eggs come from?
46. S. Don't know.
47. R. You can't remember? Never mind. [shows the next picture] What's that?
48. S. Chicken.

49. R. Do you like to eat chicken when it's cooked?
50. S. I don't like chicken.
51. R. You don't, OK. Do you like any other sort of meat?
52. S. I don't like. [pause] I like meat.
53. R. Right.
54. S. We eat meat when grandma comes on Sunday when we've been to Sunday School.
55. R. Oh right, that's good then. You have your Sunday dinner with meat. What sort of meat? Do you know? Do you know the name of any sort of meat?
56. S. I know the meat that we eat when we come back from Sunday School.
57. R. And what's it called?
58. S. And I like apples ... I like apples.
59. R. Is it pork you have?
60. S. Yeah and er, ... no, not that I have. [pause] We have meat and erm and .. and ... I have Snow White and the .. and her stepmother change into an old woman, so Snow White wouldn't recognise her. And she creep into the cottage, and she brought a poisoned apple she made a poison and she ...
61. R. Oh.
62. S. And .. and Snow White ate, ... ate a bit and fell to the ground.
63. R. Oh.
64. S. And fell asleep.
65. R. Oh.
66. S. And a prince kissed her in the glass coffin.
67. R. Oh, I see. Right. Now then, do you like to drink milk?
68. S. Yes.
69. R. Mm. Can you tell me where milk comes from?
70. S. From cows.
71. R. Oh, that's right.
72. S. And the cre .. and the cream.. and the cream comes from the milk.
73. R. What comes from the milk? Cream, did you say?
74. S. No. Cream comes from the milk.
75. R. Right, OK. How did you know that we get milk from cows?
76. S. 'Cause I just do.
77. R. You just do, oh right. [shows the next picture] What's that?
78. S. Erm [pause].
79. R. Cheese.
80. S. Cheese.
81. R. Mm.
82. S. I eat cheese.
83. R. Oh, right.
84. S. We have juicy ... We have juicy, er, ... erm, pineapple sometimes.
85. R. Do you, with the cheese?
86. S. No.
87. R. Do you know what cheese is made from?
88. S. Where?
89. R. Do you know how to make it? [pause] Cheese, do you know how to make cheese?
90. S. No.
91. R. Do you know what goes in to make it?
92. S. What?
93. R. You don't know, OK. [shows next picture] Oh, what are they?
94. S. Chicks.
95. R. Chickens.
96. S. Mm mm.
97. R. That's right.
98. S. Get chickens from eggs.
99. R. You get chickens from eggs, don't you?
100. S. Mm mm.
101. R. That's right. And you've got some in the nursery, haven't you?
102. S. Mm mm.

103. R. Right. What do you have to do to the eggs to help little chickens to come out?
104. S. You have to sit on them to keep them warm.
105. R. Right, you have to keep them warm and then they crack the shells open and out comes a little fluffy chicken.
106. S. We haven't got any cats or no dogs.
107. R. You haven't got any cats or dogs, OK right. Now then, you told me that chicks come out of the eggs of those
108. S. Mm mm.
109. R. Those hens lay the eggs don't they? Right
110. S. Mm mm.
111. R. Is that where we get our eggs from that we eat?
112. S. Yes, yes.
113. R. Right, OK. If those hens .. If those hens are hungry, what would we give them to eat?
114. S. Some of that.
115. R. Some grass?
116. S. Yeah.
117. R. What else might they eat? What else would you give them to eat?
118. S. Some hay.
119. R. Some hay, OK. [shows the next picture] Right, there's the cow
120. S. A cow ... a mammy cow.
121. R. That's a mammy cow, isn't it?
122. S. Mm mm.
123. R. Because you can see the part that makes the milk there, can't you?
124. S. Mm mm [points to the udder].
125. R. Right, have you seen the cow ...?
126. S. It's only got one, two, three
127. R. It's only got three teats that you can see there, but there's one behind it's leg that you can't see, 'cause they usually have four don't they?
128. S. One, two, three milks.
129. R. Right, that's the udder that makes the milk and those are the teats that you squeeze to get the milk out. Have you seen a cow being milked?
130. S. No.
131. R. No, oh right. But you knew where
132. S. We haven't got any cows.
133. R. You knew which part of the cow
134. S. We've got nothing. We've got noth
135. R. But you said, .. but you said you'd seen the cow at the farm?
136. S. Do you? ... Do you, ... But do you know what? Me and Rebecca and mammy and daddy haven't got anything but us, live in the house.
137. R. Right, yes, OK. When the cow's hungry, what does the cow eat?
138. S. Grass.
139. R. Oh right, grass. It's eating grass there, isn't it?
140. S. Mm mm.
141. R. Does it eat anything else?
142. S. I don't know.
143. R. Do you ... ? do you think it would eat anything else?
144. S. Hay.
145. R. Right, it would eat hay as well, that's right. What's that?
146. S. Leaves.
147. R. Yes, they're lettuce leaves.
148. S. We eat lettuce at tea time.
149. R. You do, don't you? Yes, in salad.
150. S. And salad.
151. R. That's right. Can you tell me where the lettuce comes from?
152. S. I don't know.
153. R. No, OK. [shows the next picture] What's that?
154. S. Tomatoes. We eat tomatoes, too.

155. R. Ah well.
156. S. I like tomatoes.
157. R. You do? If you cut open the tomato, what can you see inside?
158. S. Some juicy.
159. R. Some juice. Anything else?
160. S. I don't know anything else.
161. R. You don't know anything else. OK. Can you tell me where tomatoes come from?
162. S. I don't know.
163. R. You don't know. OK. [shows the next picture] What's that?
164. S. Chips. We eat chips at tea time as well.
165. R. Do you? Oh.
166. S. And dinner time.
167. R. Do you like chips?
168. S. Mm mm.
169. R. You have them quite a lot? Who makes the chips in your house?
170. S. Erm, mammy and daddy.
171. R. Oh, both of them make the chips? How do they do that?
172. S. They just make them. Put them in the frying pan.
173. R. They put them in the frying pan. What goes into the frying pan to make the chips?
174. S. Chips.
175. R. What are they made from?
176. S. Erm, ... Don't know.
177. R. Do they buy ready made chips from the supermarket, frozen? Or do they make their own?
178. S. Yes, we buy them.
179. R. You buy them. You don't know what goes in, to make them?
180. S. No.
181. R. No. OK. [shows the next picture]
182. S. Bread.
183. R. Do you like white bread or brown bread?
184. S. I like brown bread. No. I only like white bread.
185. R. What do you put on your bread?
186. S. And I like crusts.
187. R. You like the crusts? What do you put on your bread?
188. S. Butter.
189. R. Right. Do you make sandwiches sometimes?
190. S. Yes, and I like chip butties sometimes.
191. R. You like chip butties? Mm. [shows the next picture]
192. S. Huh.
193. R. What's that?
194. S. Crisps.
195. R. Well, it's cornflakes. See, bits of bowl with milk?
196. S. Mm.
197. R. Looks like crisps though, doesn't it?
198. S. Mm mm.
199. R. Mm. Do you have cornflakes for breakfast sometimes?
200. S. Yeah.
201. R. Ah.
202. S. We had it today.
203. R. Oh.
204. S. I had it.
205. R. Did you have milk on?
206. S. Yeah but we had little boxes.
207. R. Little boxes. You had one each did you?
208. S. Mm mm.
209. R. Oh, aren't you lucky? Do you know what cornflakes are made from?
210. S. Where?
211. R. Do you know how to make cornflakes?

265. R. Oh right, so what do you have to do to help the seeds to grow?
266. S. [Knock at door] Come in.
267. R. Come in. [Tape paused] When you plant the seeds, what do you have to do to help them to grow?
268. S. You have to put soil in.
269. R. Right and do they need anything else to help them to grow?
270. S. No.
271. R. No, OK.

Manor House Primary School Interviewee: A. M. Age six years

1. R. Right, A****, here's the first picture. Now what can you tell me about them?
2. A. Erm, that those two are eggs.
3. R. What's different about them?
4. A. That one's got, that one's got white and that one's darker.
5. R. Yes. Why's that?
6. A. Erm, dunno.
7. R. Right. Well, they're in a frying pan, aren't they? And, they're starting to cook. So I think that one must have been in the frying pan longer than that one, because it's, looks as though it's cooked, but that one is not cooked yet, is it?
8. A. No.
9. R. Right. So maybe someone is just going to eat that one now. Mmm. Do you like eggs?
10. A. Ah ha. I like boiled eggs.
11. R. You like your eggs boiled, do you?
12. A. Nods.
13. R. Yes.
14. A. I 'ad one of them eggs when I went to Whitby.
15. R. When you went to Whitby you had a fried egg, did you?
16. A. Mm.
17. R. Was that when you went on your holidays?
18. A. No.
19. R. Just on a day trip?
20. A. I went for the day.
21. R. Right, lovely.
22. A. I went with Mam and Carlene.
23. R. Oh, did you?
24. A. I went with my cousin and my sister.
25. R. What did you do when you were at Whitby?
26. A. Erm, we played on the machines that are inside the shop.
27. R. Oh, I know the ones. They're good fun, aren't they?
28. A. Nods.
29. R. Did you go down to the beach?
30. A. No.
31. R. No, there isn't a beach at Whitby, is there? What did you see at Whitby?
32. A. We saw, we saw that big ship. There's a big ship there.
33. R. The big ship's not been there very long. With the sails? Were the sails out?
34. A. It was a pirate ship, though. But there were no pirates on it. Just Captain Cook.
35. R. Oh, you're right, because I saw it on the Television. But I didn't go to Whitby. You're lucky to have gone and seen it, aren't you?
36. A. But we never got to go on it.
37. R. Didn't you?
38. A. No.
39. R. I didn't hear on the television that they let anyone go on it.
40. A. Well, we were allowed.
41. R. You were allowed, but you didn't have a chance?
42. A. No.
43. R. OK. But it would be very interesting just to see it so near, wouldn't it?
44. A. I know.
45. R. Oh, yes, you are lucky. What else did you do when you were at Whitby?
46. A. Er, we got a shell. Me and Christine got the shell off Pauline.
47. R. Did you?
48. A. Yes.
49. R. Oh, right.
50. A. Pauline's got one of the shells.
51. R. Did you see the little fishing boats when you were in Whitby, as well?

52. A. Yes.
53. R. Right. Did you have fish and chips while you were there?
54. A. No.
55. R. No. You had egg and chips, didn't you?
56. A. Nods.
57. R. Right. OK.
58. A. Before we went.
59. R. Right. Ah ha. Can you tell me where eggs come from?
60. A. From an egg shell.
61. R. Right. I can see some egg shells there! Right, OK. and there are some eggs in the box. Still in the box, aren't they?
62. A. Ah ha.
63. R. Where do they come from?
64. A. Erm, dunno.
65. R. Well if you wanted to get some eggs, where would you go?
66. A. The shop.
67. R. Right. Do you know where the shop might get them from?
68. A. Sainsbury's.
69. R. OK. I go to Sainsbury's for my eggs sometimes.
70. A. My Mam used to work at Iceland's.
71. R. Oh, did she? Did she get some things cut price through working there?
72. A. She doesn't work there any more.
73. R. No? When she was there, did she get special things because she was there?
74. A. Yes.
75. R. What did she get?
76. A. Er, can't remember.
77. R. OK. Let's look at the next picture. What's that?
78. A. I know. It's meat.
79. R. Mm, it's meat. What sorts of meat do you know about?
80. A. Er, the meat that I have in my sandwiches. I don't know what you call it.
81. R. OK. Right. But you like that. Obviously, this meat isn't cooked.
82. A. No.
83. R. You cook meat before you eat it.
84. A. I don't like that meat.
85. R. You don't like that sort of meat. What sort do you like?
86. A. I like the thin meat. That goes in your sandwiches.
87. R. Do you?
88. A. Yes.
89. R. Right, OK. Do you know where meat comes from?
90. A. Erm, [looks puzzled] no.
91. R. OK. [turns to next picture] Oh, right. What sort of milk do you get at your house?
92. A. [pause]
93. Do you get that sort, in a bottle? Or do you get it in the supermarket?
94. A. I get all of them.
95. R. Right. So the milk man leaves some on your doorstep, does he?
96. A. Yes.
97. R. And then when you need some more, do you go to the shop for it?
98. A. Sometimes we get that and sometimes them [pints to different containers in the picture].
99. R. Yes. Sometimes the big carton and sometimes the small one. Do you like to drink milk?
100. A. No. I used to.
101. R. Do you like milk shakes?
102. A. Yes. I like the drinking chocolate.
103. R. Oh, right. That's delicious, isn't it? Do you know what we use milk for in cooking?
104. A. Erm, no.
105. R. No. never mind. What can you tell me about where milk comes from?
106. A. A cow.
107. R. I thought you would know that. Yes.

108. A. I've seen it on television.
109. R. Oh, have you? Have you seen the cow being milked on the television?
110. A. Yes.
111. R. Oh, right. Has anyone else told you about it?
112. A. [Shakes head].
113. R. No. OK. [shows next picture] Oh, what can you tell me about that picture?
114. A. Some of the cheese has got lines on.
115. R. Yes. The cheese that's got lines on is called blue cheese. It's got a very strong flavour. It's a sort of mould. It's not bad for you, but it is a sort of mould, and it gives it a very strong flavour. I don't think children like it very much.
116. A. I like cheese slices.
117. R. Right, yes. Well that's a mild cheese. You might like this one, the yellow cheese.
118. A. I don't like that cheese.
119. R. Right, yes. Just thin slices. Do you know how to make cheese?
120. A. No.
121. R. Any idea what it's made from?
122. A. No.
123. R. No. Do you cook with cheese at all? Does your Mam cook with cheese?
124. A. No.
125. R. Oh! What are they? [Shows next picture].
126. A. Hens.
127. R. Hens. That's right. What do they eat if they're hungry?
128. A. [pause].
129. R. Have you ever seen any real live hens?
130. A. No.
131. R. Oh, right. Well that's why ... Well if you had to guess, what you would give them if they were hungry? What would you give them?
132. A. Er, some nice little nuts.
133. R. Little nuts. Right. Anything else?
134. A. No.
135. R. Right. And what gave you the idea of the nuts, then?
136. A. 'Cos we give birds nuts as well.
137. R. Right. And hens are a sort of bird, aren't they?
138. A. Nods.
139. R. That was a very good guess.
140. A. I've seen hens on T.V. though.
141. R. OK. So what did you learn about them when you saw them on T.V.?
142. A. They lay eggs.
143. R. They lay eggs.
144. A. An' I seen the tel ... , I seen them on telly this morning. Er, ... Some, some of them couldn't get up on the step.
145. R. Really? So you've seen them this morning? Hens like this?
146. A. [Nods].
147. R. Really? Did you?
148. A. [nods].
149. R. Oh, well, that was good, then, wasn't it? Oh, right. Now you know that they lay eggs, don't you?
150. A. [nods].
151. Yes, and what happens to the eggs, then, after they've laid them?
152. A. They crack them.
153. R. And what comes out of them, then?
154. A. Chickens.
155. R. Little fluffy chickens?
156. A. [Nods].
157. R. Oh, that's lovely, isn't it? Do you know where hens live?
158. A. In the farm.
159. R. Right. The farmer keeps the hens. What does the farmer want from the hens? Why does he keep them?

160. A. He wants some little chickens.
161. R. Right, he wants some little chickens. What will the chickens grow into?
162. A. Big chickens.
163. R. Right, and eventually they'll grow up to be more hens, won't they?
164. A. Yes.
165. R. So eventually he'll have lots and lots of hens, won't he?
166. A. Yes.
167. R. Yes. So why does he want them all?
168. A. So that he'll get more ... [pause]
169. R. Mmm ... But what about this first picture, here? [shows first picture, of eggs].
170. A. He'll get some more eggs.
171. R. Right. So when I asked you where we get the eggs from, what are you going to tell me now?
172. A. They come from chickens.
173. R. Right. And they come from a farm, don't they? Did you know that really all the time, or had you just forgotten?
174. A. I'd forgotten about the farm and then I remembered.
175. R. Right. Or had you not really thought that the eggs that we buy had come from the farm? Had you not really thought about that?
176. A. 'Cos that comes, ... 'cos that's the yolk and those ones lay the eggs that have yolk in.
177. R. Do they? How do you know that?
178. A. Because [unclear] come from them.
179. R. Right, I see. Well, actually, what happens is, when those hens lay the eggs, if they sit on them and keep them warm, or the farmer keeps them warm then they can hatch into little chicks. But if you just take them away before they've been kept warm, then you can eat them. [pause] All right? [pause] OK. Let's have a look at the next picture. [shows picture of a cow] Where would we find the cow?
180. A. In the farm again.
181. R. In the farm again, that's right. But this, erm, this cow is out in the field, isn't it? The farmer's field.
182. A. [nods].
183. R. That's right. Yes. What does the cow like to eat?
184. A. Grass.
185. R. Grass, that's right. It's eating grass in the picture, isn't it?
186. A. [nods].
187. R. Now, you told me that cows make milk. Can you tell me which part of the cow the milk comes from?
188. A. There [points to udder].
189. R. That's right, that's the cow's udder there. Those are the teats, that you have to squeeze to get the milk out.
190. A. They put the bucket underneath.
191. R. Right. Now, have you seen a milking machine on the television? Have you?
192. A. No.
193. R. No? They can use a machine, that sucks the milk out of those teats. Or, the farmer can do it by hand. He squeezes the milk out. He puts a bucket underneath to catch the milk, doesn't he?
194. A. I've got, we've got two films, City Slickers, and Mitch finds a cow, that's going to have a baby.
195. Oh, right.
196. A. City Slickers.
197. I don't know that film. Anyway, it tells you in the film, in the video, you mean?
198. A. And the other one, he's growing big, and he's still one.
199. Oh, right, and that's the calf, is it? The baby calf, from the cow?
200. A. Nods.
201. R. Right, OK. And what does the calf eat?
202. A. Grass.
203. R. Right, OK. Very good, and how do you know all this about cows, is it just from the film?
204. A. Yes.
205. R. Have you been to a farm ever, yourself?
206. A. With me Nana.
207. R. Oh, right. Isn't that nice?

208. A. And the first little piggies, and their mother.

209. R. Oh, isn't that lovely? How long ago was that? Can you remember?

210. A. And we went with big school.

211. R. Oh, right. Did you go to the nursery at all, before you came to this class?

212. A. I went er, to play school. I just went there.

213. R. Right. Did they take you to a farm?

214. A. Yes.

215. R. Oh, lovely. Right, so you know all about cows, don't you? Do cows like to eat anything else besides grass?

216. A. No.

217. R. No. Oh, right. [turns to next picture] What's this one?

218. A. A cabbage.

219. Yes. Do you like cabbage?

220. A. Yes. I eat it for my Sunday dinner.

221. R. Oh, yes. It's good isn't it? Now, if you wanted to get a cabbage, what would you do?

222. A. I'd plant them. My Uncle John [unclear]

223. R. Does he grow them?

224. A. Yes.

225. R. So how would you start off, then?

226. A. I would get the, I would get the seeds.

227. R. You would get the seeds. Right, and then what would you do?

228. A. Erm, I'd plant them in the soil, and water them.

229. Right, you'd plan them in the soil, and water them. Do they need anything else, besides water?

230. A. Sun.

231. R. They need the sun, that's right. What for? Why do they need the sun?

232. A. So they'll grow.

233. R. Right, OK.

234. A. Uncle John's got a big garden, that's why.

235. R. Right. What else does he grow?

236. A. Carrots. Not just carrots, pea pods.

237. R. Peas, as well. Anything else?

238. A. And carrots.

239. R. Carrots. Do you ever help him? [pause] In the garden? What does he have to do?

240. A. He erm, he cuts the grass and he chops the hedge.

241. R. OK. Very good. Let's see what this one is. [shows next picture]

242. A. Tomatoes.

243. R. Oh! Right.

244. A. I like tomatoes.

245. R. Oh, right. Do you?

246. A. [nods].

247. R. Yes. I do, as well.

248. A. The little orange ones is the best. They're lovely.

249. R. Well, that's a little one [points to picture], but it's not an orange one, is it? I think you could fit all that one in your mouth at once, couldn't you?

250. A. I done that before with the orange one.

251. R. Oh, have you? Do you know how we get tomatoes?

252. A. No.

253. R. No. What do you think? What do you think you might do, to get some tomatoes?

254. [long silence]

255. What's inside the tomato?

256. A. Seeds.

257. R. Right.! Seeds. So that would give you a start, wouldn't it?

258. A. They grow from seeds.

259. R. They do, don't they? That's right, yes. [shows next picture]. Do you like chips?

260. Yes. But I don't like that [points to picture].

261. R. That's curry sauce. Not everyone likes it.

262. A. I like fish and chips.

263. R. Oh, right. That's delicious, isn't it? Who cooks chips in your house?

264. A. Well, my mammy does when we have it from the house, but when we have fish and chips we don't cook them.

265. R. You get them from the shop. Yes, I do that sometimes.

266. A. My sister's worked from that shop before.

267. R. Has she?

268. A. Yes, 'cos we've [unclear]

269. R. So you can just go and get the fish and chips?

270. A. Yes, you just go round the corner, then round another corner, then you're there.

271. R. Oh, right. That's very good, then. Very handy. So you don't really need to cook chips at home?

272. A. It's an easy trip to the video shop an' all.

273. R. Oh, right. So its very handy, isn't it? Do you know what chips are made from?

274. A. Yes.

275. R. What from?

276. A. Potatoes.

277. R. Right. And maybe sometimes you have mashed potatoes, and boiled potatoes and roast potatoes.

278. A. Yes.

279. R. Right. And do you know where potatoes come from?

280. A. [unclear]

281. R. What sort of thing do you think they are?

282. A. They grow from seeds.

283. R. Right. OK. So they're things that grow, aren't they?

284. A. [nods].

285. R. Yes, OK. [shows next picture].

286. A. I eat bread with my chips.

287. R. You like bread with your chips, do you? Do you like white bread or brown bread?

288. A. Both.

289. R. Oh, right. Both. That's good, then. Do you know how you could make bread yourself?

290. A. No.

291. R. Any ideas at all?

292. A. No, 'cos I only bake cakes and biscuits with me Nana.

293. R. Oh, right. So you do know how to make cakes and biscuits, then? And your Nana's helped you? That's very good, isn't it?

294. A. And once I was allowed to do it on my own.

295. R. Were you?

296. A. 'Cos my [inaudible] gonna be very good as well.

297. R. Right.

298. A. So I was allowed to stir the bowl and put the things in.

299. R. Oh!

300. A. And I read the recipe.

301. R. Did you? You even read the recipe yourself. You are good, aren't you? Did you have to weigh things out, then?

302. A. Mm.

303. R. Did you have to use the scales, to do that?

304. A. Yes.

305. R. Oh, you are grown up.

306. A. I'm six.

307. R. Oh, and so what sort of things go into cakes and biscuits?

308. A. The shapes that you use. You can make squares.

309. R. You can use shapes to cut them out, can't you?

310. A. I use [unclear]

311. R. When you put things into the mixing bowl, what sort of things go into the mixing bowl?

312. A. Some milk and egg, and [pause]

313. R. Those are the things we've been talking about, aren't they?

314. A. Aha, and erm, sugar,

315. R. Right, sugar. Do you think sugar goes into bread?

316. A. [nods].

317. R. It might do. It isn't as sweet as cake and biscuits though, is it?
318. A. No.
319. R. No.
320. A. You might
321. R. So it's not a good idea to put sugar into bread.
322. A. I put a little bit of sugar in my cereal as well.
323. R. Oh, right, yes. And what else goes in to both cakes and biscuits, and maybe ...
324. A. And scones, I bake.
325. R. Oh, right, and scones.
326. A. Cheese scones.
327. R. Lovely. So what is the other stuff that you have to put in?
328. A. Erm, flour.
329. R. That's the important one, isn't it? Flour. And you need lots of flour for making bread, as well. Flour is white, and so is the bread. Isn't it?
330. A. I put on my Nana's new apron.
331. R. Aren't you lucky? Do you know where flour comes from?
- Do you know what it's made of?
332. A. No.
333. R. OK. [shows next picture]. Oh. Here's something you like, I think. You more or less told me before. [pause] What is it?
334. A. [pause].
335. R. Well, that's corn flakes.
336. A. No.
337. R. Oh, well you said you had sugar on your cereal. But it wasn't corn flakes, then?
338. A. No, it's porridge that I have.
339. R. Oh, OK. So you don't like corn flakes?
340. A. No.
341. R. No. Have you any idea what corn flakes are made from?
342. A. [shakes head].
343. R. No. [shows next picture] What's that?
344. A. [shakes head].
345. R. Well, it's macaroni, and it's a sort of pasta.
346. A. I had it before.
347. R. Right. What's sort of pasta do you like?
348. A. That kind.
349. R. You do. Oh, you've just remembered, [laughs]. OK. So it's a sort of pasta. What sort of sauce do you like on your pasta?
350. A. Tomato.
351. R. Oh, right. Well, this is a cheese sauce. Most people like tomato the best. That's right. Do you know what pasta's made from?
352. A. No.
353. R. No. Do you know how to cook it at all?
354. A. Me Mam and my daddy does.
355. R. Right, OK. Perhaps you've seen them doing it, have you?
356. A. [nods].
357. R. Right, OK. You've helped making cakes and biscuits. Do you help making anything else in the kitchen?
358. A. Yorkshire puddings.
359. R. Oh, well. You are a lucky girl. Do you know what that is? [next picture].
360. A. Spring onions.
361. R. Right, spring onions.
362. A. I know a joke about spring onions.
363. R. Go on, tell me.
364. A. What's green and white and you cut them down?
365. R. I don't know!
366. A. Spring onions!

367. R. Oh, it springs! Oh I see. Of course. Those are growing in someone's garden, aren't they? And you've told me about how things grow, haven't you? Have you grown anything yourself?
368. A. Erm, yes, I've grown lots of seeds.
369. R. Were they things you could eat?
370. A. They were flowers.

Manor House Primary School Interviewee: R. H. Age eight years

1. R. Right, R****, Let's have a look at the first picture.
2. H. Er, yellow yolk, ...
3. R. Uh huh. [pause] Right, so we're looking at some eggs, aren't we? They're frying in the pan. Right. You've seen the yellow yolk. The white's cooked on that one, isn't it?
4. H. So that one's just been cracked.
5. R. Yes. It's just been put in the pan. So it's not cooked yet. How do you like your eggs cooked?
6. H I like mine fried as well.
7. R. Oh, right. Do you like them cooked any other way?
8. H. Mm. I like them poached, as well.
9. R. You like them poached. OK. Not scrambled or boiled?
10. H. I like scrambled as well. But not boiled.
11. R. Right. OK. What can you tell me about where we get eggs from?
12. H. We get eggs from hens.
13. R. Right. How did you know that?
14. H. Because, erm, when my Mam, because, she told me. And after that I went to a farm to see hens lay eggs.
15. R. So you've been to a farm. Did you go with the nursery? Were you in the nursery?
16. H. Erm, I was in the nursery, but that was our school trip.
17. R. Right. So you've been to the farm more than once, by the sound of it. [shows next picture]. What can you tell me about that? [pause] Do you know what it is?
18. H. It looks like some beef or pork.
19. R. Yes, it's meat. It's lamb, actually. Can you tell, erm, where we get meat from?
20. H. Cows.
21. R. Right. What sort of meat do we get from a cow?
22. H. Erm, [pause].
23. R. Do you know the name of the meat that we get from a cow?
24. H. [shakes head].
25. R. Do you know the name of any other meats? Well, you told me one, didn't you? You told me beef and pork. You don't know which animal they come from?
26. H. Well, pork comes from pigs.
27. R. Right.
28. H. And the meat comes from [very long pause] Does it come from bulls, or something like that?
29. R. Yes well, you told me meat comes from a cow.
30. H. 'Cos, when I went to the farm, it looked like bulls and cows.
31. R. Right. Well, in the main, the cows are kept for a different purpose, which we'll talk about in a minute. They are the females. And the males are called bullocks, when they're young. And bulls when they're grown up. But it's the bullocks that we get the meat from. So we don't let them grow up into bulls.
32. H. When I have Sunday dinner I normally have meat.
33. R. But you don't normally talk about where it comes from. It might put you off [laughs].
34. H. Sometimes I have lamb. Not that often.
35. R. OK. Right. OK. And lamb comes from?
36. H. Sheep.
37. R. Yes, that's right. So you know the different sorts of meat all come from different animals, don't you? Now, let's go back to the last picture, of the eggs. Can you tell me why eggs are good for you, when you eat them? [pause] What do they give us in our diet? Can you remember that?
38. H. [Very long pause]. Protein?
39. R. Good. Right. Very good. And what about the meat?
40. H. [Very long pause] Does it give us some carbohydrates?
41. R. It gives you some carbohydrates, the meat. Yes. Is that the only reason why it's good for you?
42. H. Erm, ... [long pause].
43. R. Do you know why we need protein and carbohydrate?
44. H. Because if we didn't have any, erm, our bodies would be very unhealthy.
45. R. Right. [shows next picture, long pause]. Where does milk come from?

46. H. Cows.
47. R. Right. And what is milk good for? Why do we drink milk?
48. H. [Long pause].
49. R. Do we need milk? Could we get by without it, do you think?
50. H. Erm, no. You can't really get by without it. Because I drink a lot of milk. Because it's my favourite drink.
51. R. Oh. [smiles]
52. H. And I have it in my packed lunch, as well. Every day.
53. R. Oh.
54. H. So, that and milk drink. There's hardly any left for my Dad's tea.
55. R. Oh, I see. So we've got to keep an eye on you, then! [shows next picture].
56. H. Cheese.
57. R. Right. Do you know why cheese is good for you?
58. H. [long pause, shakes head].
59. R. No? Do you know what it's made from?
60. H. Is it protein?
61. R. Right. So you're now going back to the first question, aren't you? So it's good for us because it's got protein in. That's right. Do you know what cheese is made from?
62. Er, is it flour and milk? Has it got any flavours in it?
63. R. It got a strong flavour, hasn't it? Do you know where the taste comes from?
64. H. [Long pause].
65. R. The strongest cheese is that one. And you can tell by looking at it, what might be giving it the taste.
66. H. It's got green bits.
67. R. Yes. That's right. It's a sort of mould.
68. H. My mam, my mam loves that cheese. And when, when we went to Scotland to see our friend, she, she bought some of it. Because our friends live in Scotland.
69. R. Oh, right.
70. H. And we normally get some fish from there. And then we come home and eat it.
71. R. Oh, right. Very good. You don't need flour to make cheese. You just need the milk, actually. And because of the processes it goes through, it develops quite a strong taste. And it's got salt in it, as well. Right. So that's the cheese. [shows next picture]. Now, you told me about chickens before, didn't you? Right. Can you tell me a bit more about it now, then?
72. H. Erm, [pause] chickens, erm, erm, they, they like wandering about ...
73. R. Yes,
74. H. And then, most of the time, and they like eating, erm, [pause] grains.
75. R. Grains. That's right. Have you fed them at all, yourself?
76. H. Yes.
77. R. Right. Yes. And when they're wandering about, what are they doing? [long pause] Looking for?
78. H. They're looking for, er, grains.
79. R. They're looking for things to eat, yes. It's not only grains that they might like to eat, I mean they're looking for their own food. But not averse to eating worms, if they find them. We don't feed them worms. If they find a worm on their own, all well and good, but we give them grain, as you said. They also eat bits of plant that they find, grass and weeds. OK. Now, you told me that they lay eggs, didn't you? Can you tell me why the hens actually lay the eggs?
80. H. Because, er, if the hens don't lay the eggs, we wouldn't be able to make cakes. Because most of the ingredients ...
81. R. Most things that we bake have got eggs in. That's right.
82. H. So you wouldn't be able to have nice cakes, if you didn't have eggs.
83. R. Right. So the farmer keeps the hens to get eggs from them. Do we get anything else from hens besides eggs to eat?
84. H. Mm [long pause].
85. R. Can we eat the hens?
86. H. [Long pause].
87. R. Have you ever eaten chicken leg?
88. H. I've ate chicken legs before, but I haven't ate hen legs before.
89. R. Well, it's the same thing, except it's a young one.
90. H. I've had, I've had, like, these little chicken, chicken legs, baked in batter.

91. R. Right. but you haven't really thought about where they came from. If you think about it too much when you're eating it, it might put you off, anyway [laughs]. OK. Now, if the hens were wild, and the farmers weren't collecting the eggs, what would they be for? Why would the hens lay the eggs?
92. H. Because as well as them we need food. And the farmers, they can pack them up for us to buy.
93. R. Yes, but if the hens were wild? [pause] The hens have a use for the eggs themselves, if the farmer didn't take them away. There's a reason why hens do lay eggs. [long pause] Some of the eggs, we don't eat them. What happens to them?
94. H. Do they get rotten and we can't eat them? [pause] Do they get chicks from them?
95. R. Right. That's what I'm after. What can you tell me now?
96. H. The hens that are wild have chicks. And the hens that are not wild, don't.
97. R. Well, where do we get more hens from?
98. H. [Long pause].
99. R. If the farmer hasn't got enough hens, and the old ones die, where will he get some new, young ones from?
100. H. Erm, from the wild, from the wild hens. They lay eggs that form chicks. And then ...
101. R. What happens to the eggs, if the farmer wants some more hens? You don't need to use wild hens. These hens will do fine. [pause] There are some eggs that we don't eat. And when the farmer wants some more baby chicks, what happens? [pause] You know, I was in the nursery er, just after Easter. And they had a picture up on the wall of some hens like that [points to picture], and some little baby fluffy chicks [pause], and some egg shells. [pause] I'm sure you've seen pictures like that, haven't you? Isn't there one at the front of the school? [pause] So if the farmer wants some more hens, [pause] he has to keep the eggs warm for three weeks, and turn them over twice a day. And there's a little pecking sound, and the egg shell cracks, and what happens then?
102. H. And then the baby chicks start to come out.
103. R. Right. You knew, really, didn't you? I wouldn't have told you, if I didn't think you knew. Isn't that right? Didn't you know all that really? [pause] You hadn't linked it all up in your mind, had you? [laughs]. So, these eggs there [points to first picture], if you keep them warm, ...
104. H. They, they would be chicks.
105. R. Then, little chicks would hatch out. But if you, if you don't keep them warm, and you crack them open, [points to picture] that's what you see.
106. H. So, it depends if the farmer keeps them warm for three weeks, they turn out as chicks, and if they don't keep them warm for three weeks, they turn out as plain eggs?
107. R. If you just keep them cool, ...
108. H. They turn out as eggs?
109. R. Mm. They've got to be kept at just the right temperature, and turned over twice a day, or nothing happens. All right?
110. H. Mm.
111. R. So, if it takes three weeks to hatch, if we looked at them half way between when they were laid and when they hatch, inside those eggs, what would we see, do you think?
112. H. [Very long pause].
113. R. Don't know, do you? [laughs].
114. H. [shakes head].
115. R. If the hens were wild, and there was no farmer to incubate them, do you know how the hens would keep them warm?
116. H. Do the hens keep them warm, themselves?
117. R. Yes, they do.
118. H. By, by sitting on them.
119. R. That's right.
120. H. Once they've laid them, do they just, ... sit there?
121. R. Uh, huh.
122. H. And keep them warm?
123. R. And turn them over twice a day.
124. H. But how do the hens turn them over?
125. R. Well, when my daughter was about your age, she said, "If I had to sit on those lumpy eggs, I think I'd start fidgeting and turning them over! [laughs]. So that's how it does it, really. It just fidgets, and moves about, and that gets them turned over. If we do it, we know it's got to be at least twice a day, but

the hen sort of fidgets quite often. It gets up now and again to get a drink, or peck some food. And then it comes back and sits on them.

126. H. But are they still warm when they get up?

127. R. Well they stay warm for a little while. If they stay away too long, then they go cold. You probably know about birds, having nests, don't you?

128. H. Yes.

129. R. Well, it's the same thing. Because these are sort of birds, aren't they? They're just bigger. [shows next picture].

130. H. That's a cow.

131. R. Right. Now, you told me that the cows make the milk, didn't you?

132. H. [Nods].

133. R. Right. And now we're going to think about how this all fits together. Are you getting tired? Is it straining your brain, all this?

134. H. No.

135. R. OK. So, first of all, what do cows eat?

136. H. Grass.

137. R. Right. You can see it eating the grass, there. Does it eat anything else?

138. H. Er, can it eat hay?

139. R. It can eat hay, as well. Which is dried grass, you know. And how is the milk made? What do you know about that? [pause] Can you show me which part of the cow makes the milk?

140. H. [Points to picture].

141. R. Do you know it's name?

142. H. [shakes head].

143. R. That's called the udder, that makes the milk. And those are the teats, that you squeeze to get the milk out. Didn't you tell me that you'd seen cows being milked? Did you say that?

144. H. Yes. I've seen them being milked, but I haven't heard the names.

145. R. Right. Was it with a machine, or by hand?

146. H. By hand.

147. R. Oh, right. Into a bucket?

148. H. Yes. And there's a bucket held underneath. And then they put them in a special thing, I don't know what they're called.

149. R. A stall.

150. H. And then they squeeze the milk out.

151. R. OK. So now, just as we were talking about why the hens lay the eggs, we're thinking about why the cows make the milk. [pause] What can you tell me about that? [long pause] Obviously, we keep the cows because we want the milk. But that's not why the cows started off making milk, before the farmers caught them, and kept them. because they were wild, as well, to begin with, you see. So what, what's the purpose from the cow's point of view, for making milk?

152. H. [Extremely long pause]. Does it have something to do with the white on the cow?

153. R. You can get brown cows [laugh]. Right, so the cow, basically, makes the milk to feed it's own babies. The calves. But we breed the cows to make more milk than the babies need. So, when the calves are a few days old, they're taken away from the mother cow. The cow is milked, and only some of the milk goes to feed the calf. And we drink the rest. [shows next picture].

154. H. Cabbages.

155. R. Right. That's actually a lettuce. But they look very similar. Now, we're on to plant food, aren't we? So. It doesn't matter whether it's a lettuce or a cabbage. How would that be good for us?

156. H. Erm, 'cos that's mixed in with a salad. And the salad's normally very good for us.

157. R. Mm. Do you know especially why?

158. H. [Shakes head].

159. R. OK. Have you seen lettuces or cabbages growing at all?

160. H. Not particularly. But I've seen one, I've seen the seeds being scattered. But I haven't seen them actually growing.

161. R. Oh, right. So who scattered the seeds?

162. H. Erm, when I went to the farm, the farmer was scattering the seeds. Once, once the cabbages have all gone, I saw the farmer scattering some seeds about.

163. R. Right. Did he use a machine, or did he do it by hand?

164. H. Well, I saw him doing it by hand. He had a bag full of seeds. And he just got handfuls and scattered them.
165. R. Oh, right. I'm surprised, actually. If there's a big field, they usually have a machine to do it. And if it's a small vegetable plot, then usually, you plant them more carefully than just scattering them, as you just said. Have you grown anything that you can eat, yourself?
166. H. Not particularly. My Mam, my Mam normally plants things, but they're just plain plants. But my Mam's friends let us have some mint. Stuff like that.
167. R. Oh right. Ah ha. Those are called herbs, aren't they? For flavouring.
168. H. And then we use them. They grow, erm, things as well.
169. R. What sort of things?
170. H. Erm, a few cabbages. And tomatoes.
171. R. Oh, right. So you've had quite a few chances to see things growing, then, that you can eat. Haven't you? And if you wanted to grow some lettuce or cabbage, what would you do?
172. H. [Long pause].
173. R. You must have planted some seeds, haven't you? Even if they were not things that you can eat?
174. H. You would pull off the outside, and then you could just eat it.
175. R. Mm. Well, if you start off from the beginning, with a packet of seeds. You've done it, haven't you? What do you have to do for the seeds, to help them to grow?
176. H. Water them.
177. R. Right. Do they need anything else besides water? [pause] What else will they need, as well?
178. H. [Long pause].
179. R. Have you done any experiments to find out?
180. H. We've done experiments on flowers.
181. R. Yes. Right. And what do they need to grow, then? It's not just water, is it?
182. H. They need oxygen, as well.
183. R. Right. How did you know that?
184. H. Because we did, when I was in this class, like in December, we learned about gas and oxygen, ...
185. R. Oh, did you?
186. H. And how they combine together.
187. R. Oh, right. Did you do any experiments?
188. H. Erm, we didn't do any experiments about oxygen gas, but we did about food. 'Cos I went over to the table with eggs, flour, sugar, and milk, and you had to have a look at it. And then you had to wash your hands, and put your finger in it. See how it felt. And then you had to write down what it felt like. And at the end, you cooked them. And ate them.
189. R. Right. That's good. Right. OK. How many different things that you can eat have you seen actually growing?
190. H. Erm, [pause].
191. R. Have you seen lettuces growing?
192. H. No, but I've seen other types of foods growing. Like potatoes and tomatoes.
193. R. Oh, right.
194. H. Because my, just my friend across the road. He's old, but he's got a greenhouse, and he grows lots of tomatoes.
195. R. So, one of your neighbours, really.
196. H. Yes. So I normally go round, and have a look. And they keep turning red. And he washes them and then he eats them, in a salad.
197. R. Very good. That takes us onto our next picture very nicely, doesn't it? [shows picture of tomatoes]. Do you like tomatoes?
198. H. Yes. I eat cherry tomatoes and big tomatoes.
199. R. Oh, right. That looks like a cherry one there, doesn't it? That little one.
200. H. I've got some in my packed lunch, today.
201. R. Oh, lovely.
202. H. 'Cos I've got loads of them at home. 'Cos my sister adores cherry tomatoes. So we have to buy them, like, we have to buy boxes.
203. R. Right. If I wanted to grow some tomatoes, what would I start off with?
204. H. [Extremely long pause].
205. R. If you cut open a tomato, what would you see inside it?
206. H. The seeds.

207. R. Right. That's all. I think you're expecting these questions to be harder than they really are [laughs]. [Shows next picture].

208. H. Chips.

209. R. Right. OK. Chips.

210. H. They're made out of potatoes.

211. R. Good. Right. Who cooks the chips in your house?

212. H. My mam.

213. R. Right. And how does she do it?

214. H. Sometimes she puts a stir fry in. Sometimes she uses that. But most of the time she just uses plain chips. She puts them in the oven on a tray.

215. R. So those are ready cooked chips, that she got frozen. Right. But you know that you do make them from potatoes, because you've just told me that. So you told me that you've seen potatoes growing. Do you know how plant potatoes? [pause]. What do you start off with when you're growing potatoes? [pause] Have you seen anyone do it?

216. H. No.

217. R. No. Do you where you would find the actual potatoes when they are ready?

218. H. [Pause] In big sacks?

219. R. Well, we put them into big sacks. But when the potatoes have been growing, and they're ready for us to harvest them, how do we get them?

220. H. No.

221. R. Because they grow under the ground, you see. You can see the leaves coming up, but you have to dig up under the roots to get the potatoes out of the ground.

222. H. My mam has new potatoes, and you can see the little roots growing.

223. R. Right. Well that shows you what you plant. You plant small potatoes in the soil, and they grow roots out of the potatoes themselves. They're called tubers, the potatoes that you eat. And shoots grow out. And they come up, above the ground, and then some new, little potatoes grow under, by the roots. So you haven't seen all that have you?

224. H. No.

225. R. But you knew they grew. Which is fine. The little children don't even know that chips are made out of potatoes. How are potatoes good for us?

226. H. Because potatoes are good for us as well as that. When potatoes are developed into chips, that means the chips are still healthy.

227. R. Except if you cook them in fat. The fat's not so good for you, if you have too much.

228. H. No. If you have lots and lots of fat, it's not good for you. But if you just have a little bit of fat, ...

229. R. That's OK. But you don't have to have potatoes made into chips, as you know. You can eat potatoes in other ways, as well.

230. H. You can roast potatoes. And you can just leave them plain, without the fat. I like them roast.

231. R. And they do have fat. [shows next picture].

226. H. Bread.

227. R. Right. Do you know why bread is good for you?

228. H. [Long pause] Because, er, because it gives a lot of, erm, protein.

229. R. Right. You get protein from bread. Anything else?

230. H. Erm, carbohydrates?

231. R. Carbohydrates, yes. What do you know about how bread is made, and what it's made from? Have you seen bread being made at all?

232. J. No.

233. R. No. Do you know what it's made from?

234. H. [Long pause] Wheat.

235. R. Good. How did you know that?

236. H. Erm, [pause] because, it's the same colour [inaudible] I see everything how what bread, ... Because I've actually seen what bread, how is bread, how bread is made. 'Cos I went to this little hut, and I saw, I saw the wheat and grains, and then I saw the wheat grains being made into bread. Because, ...

237. R. In pictures, you mean?

238. H. Yes. And all these little, little holes in the bread. Because the grains in wheat haven't been put into that part of the bread.

239. R. So it's left a space.

240. H. [Nods].

241. R. Right. OK.
242. H. So they have, it hasn't been put as much grain into ...
243. R. It sounds as though it's a sort of museum you've been to, with an exhibition and explanations.
244. H. Yes. It's like, they actually tell you how it's being made.
245. R. Right.
246. H. And they've got pictures, different sequences, how it's being made.
247. R. There's another way of knowing how you make bread that you haven't really thought of, and that's the story of The Little Red Hen.
248. H. Yes. I've read it quite a lot.
249. R. I thought you would have done. So that gives you all the stages, doesn't it? Would you like to take me through those?
250. H. Erm, the, the little red hen has to do everything in the house, because erm, the ...
251. R. You don't need to tell me all the story, just the stages of how the bread's made.
252. H. The, the little red hen goes round to get some, ... she goes round to plant some seeds, ...
253. R. Right. She starts off by planting seeds. And what are they?
254. H. Erm, ...
255. R. Grains of?
256. H. They're grains of, er, ... They're grains of the wheat?
257. R. That's right. Good. Do you know what wheat looks like, when it's growing?
258. H. [Shakes head].
259. R. Well, probably you saw pictures of it in The Little Hen book. I don't know which book it was, you saw.
260. H. It's got like, little tiny leaves. And it's got both sides growing up. And at the top it's got one.
261. R. Right. Those are the new grains. So the hen plants some grains, the plants grow. Just as the seeds that you've talked about, ...
262. H. You put some water on, and then once it's like, some [inaudible] the little red hen pulls it, and er, makes it into grain.
263. R. Right. What I want really, is the stages. She plants the wheat, grains. The wheat plants grow. And lots more grains grow on the stalk. And I think that's what you had in your mind when you told me that bit. And when she gets the grains of wheat, what does she do then? [pause] Because you don't make the bread from just grains of wheat, do you? You have to do something to it. Can you remember what she had to do? [pause] Took it to the miller [pause], ground it into flour, ...
264. H. Ground it into flour, and she brought the flour home, and then [inaudible] with, ...
265. R. She mixed it. Because you haven't done it yourself, you can't remember all about it. Have you made cakes with your mam at home?
266. H. Yes.
267. R. Oh, right. Well, it's the same sort of idea. And you use flour for making cakes. So you're used to flour, aren't you?
268. H. And then, then she puts some, ... she puts some. Do you need milk to put in?
269. R. You don't actually need milk to make bread. Water will be all right. It's mainly flour and water.
270. H. She puts, she puts it in the oven.
271. R. Yes.
272. H. And then it rose.
273. R. Right.
274. H. And then she watches how high it goes. And then she brought it out of the oven and gave it to the others.
275. R. Well, she said, "Would you like to eat it?" and they said, "Yes." And she said, "Oh no, I shall eat it myself." That was the story, wasn't it?
276. H. Because they didn't, er, they didn't help the little red hen do anything.
277. R. That's right. Now you have made cakes. Do you know what makes the cakes go light and fluffy?
278. H. [Shakes head].
279. R. No?
280. H. Is it the flour?
281. R. You add something to the flour.
282. H. Baking powder.
283. R. Right. Well done. Do you now what the baking powder does?
284. H. It makes the cakes rise, ...

285. R. Yes. OK.

286. H. ... in the oven.

287. R. Can you see anything that it does before you put the cakes in the oven?

288. H. [shakes head].

289. R. No. OK. Now, when you make bread, you don't use baking powder. You use yeast. Do you know anything about yeast?

290. H. Not really. But I've heard of yeast.

291. R. No. OK. Well yeast is actually a little plant, and it grows. It's like a fungus. And it grows with sugar and water. So when you make the bread mixture, which you call dough, you mix up the water with the flour. But you don't just use ordinary cold water. You have warm water, with a teaspoon or two of sugar in it, and some yeast.

292. H. We made some.

293. R. So now you've remembered. OK. Where did you make the dough?

294. H. At home. Because I remember my Mam putting her hands in it and mixing it all up.

295. R. Do you remember the yeast? Because the thing about the yeast... Because it's alive, it has to be warm, and it has to have to have water and sugar to grow. And do you know what it does? [pause] Did you see what effect it had? [pause] If you just put it in the water, without the, the flour, so that you can see what happens, you can actually see that it makes a lot of bubbles. And it's the bubbles that make the holes in the bread.

296. H. Oh.

297. R. So you've actually seen someone make the bread. You'd just forgotten. But as soon as I said, the dough, you remembered. Because of the special word. Is that what reminded you?

298. H. It was probably last January. We were just about to go away on holiday, and she didn't want to have to go out and buy some. She had to get rid of the flour, because it was nearly off, and she had to get rid of it. So she made some bread. When you said the word 'dough' I remembered my mam making dough.

299. R. Right. OK. Very good. Let's go on to the next one, now.

300. H. Corn flakes.

301. R. That's right. Do you know why they're good for you?

302. H. [Pause] I've had them before.

303. R. Mm. Do you have cereal for your breakfast, usually?

304. H. [Nods].

305. R. Right. OK. Can you think, er, what cereals give you that's good for you?

306. H. Er, All Bran.

307. R. Uh huh. [pause] I didn't ask you which cereals, I asked you what's good for you about them.

308. H. [Pause]. What's in them. I depends. If, if it's like, Nesquik, that's chocolatey. And chocolate's not that good for you. So, erm, it's got raisins, ...

309. R. You can put raisins in it, yes.

310. H. Yes. I've forgot what's the other name is. But that's got raisins, and all ...

311. R Museli.

312. H. Yes. I used to drink that a lot. I used to have it a lot. And my mam said that it , that it had a lot of good things in. So, I just liked it. And then suddenly I changed to corn flakes.

313. R. Do you know what corn flakes are made of? [Pause] The name gives you a clue, doesn't it?

314. H. Corn.

315. R. Mm. Do you know what corn is?

316. H. It's a bit like wheat.

317. R. That's right. That's a good description. What's different about it?

318. H. Because corn is, I've tasted corn and wheat, when it's not mixed with anything. And the corn tastes stronger than the wheat.

319. R. Mm. Do you know what it looks like?

320. H. [Shakes head].

321. R. Have you had corn on the cob? Sweet corn?

322. H. Yes.

323. R. Right. Well, you know what that looks like? That's got grains on it, hasn't it? But the grains are bigger than the wheat grains. And they're yellow, and a squarish shape. So if you've eaten sweet corn, you'll know. If you let the corn on the cob, sweet corn, ripen on the plant, it actually goes into hard

yellow grains. Much more like the wheat grains, with flour. You can get flour out of the middle. So corn flakes are actually the hard grains that you can get from corn, squashed, to make a flake.

324. H. But how come the corn flakes are hard?

325. R. Well, they've actually been cooked, to make them crispy. If you have a look at the ingredients on the packet, to see what it's made of, you'll see that it's mainly corn. But there are a few other things in it as well. [shows next picture].

326. H. Pasta.

327. R. Right. Do you like pasta?

328. H. [Nods] With cheese sauce.

329. R. Right. OK. That one's got cheese and broccoli on it. That's macaroni. You probably have other things as well, like spaghetti and so on. Do you know what's good for you in that?

330. H. Erm, the cheese sauce, because as well as the pasta, it's the cheese sauce. Because the cheese is good for you.

331. R. Right. The pasta's good for you as well. Have you any idea why?

332. H. [Shakes head].

333. R. No? Do you know what it's made from?

334. H. The pasta?

335. R. Mm.

336. J. [Long pause].

337. R. Well, it's made from flour, as well.

338. H. A lot of these things are made from flour!

339. R. It's amazing, isn't it? Yes. If you have a look at the packet, you usually see that it's made from durum wheat. So it's not County Durham. It's a sort of wheat that makes particularly good pasta. Now, you quite rightly said that a lot of these things are made from wheat, which is a sort of grain. So, although we don't eat wheat grains, just off the plant, when they're hard, we do when it's been ground into flour, and made into these different things. Do you know of any other grains, that we eat? [pause] What about rice, for instance? Do you eat rice sometimes?

340. H. Yes.

341. R. That's another sort of grain. You can see it's like a seed, if you think about it, can't you?

342. H. It's like, it's like an egg, but much, much thinner.

343. R. [Laughs] In a way. But it comes from a plant, like the wheat. OK. Now, this is the last picture. [Shows it].

344. H. [Pause] I've forgotten what the name is, now. Is it a leek?

345. R. That's a pretty good guess. It's onions, growing in some one's garden. Yes, leeks and onions look the same when they're growing. So that's good.

346. H. How do onions have these little green things?

347. R. Well, if you think about the brown onions that you cook with, you know that the brown part on the outside is sort of, papery. It's really sort of dried up leaves. And if you look at the top of the onion, you can see the bottoms of these leaves that fell off. You know there are dried up roots at the bottom? The top, if you look next time you see an onion. You these brown bits, and that's the leaves, when they've finished growing and dried up, and fallen off.

348. H. So, what is that? Is that onion still OK to eat?

349. R. Mm. That's the part that you eat. Just getting fat, there. It's not fat enough yet.

350. H. My mam always, she doesn't pick the ones ... She normally picks the ones with little bits of brown on. But she doesn't pick the ones with loads and loads of brown.

351. R. Well, there's different sorts of onion. I'm not sure if you're talking about spring onions, where you eat all the ...

352. H. Yes.

353. R. Spring onions, you eat the whole thing. The leaves, as well. But although these look like spring onions just now, they're not. They're going to get fat at the bottom, and the leaf part dries and falls off.

354. H. And there'll be just leaves on the soil?

355. R. Yes, but it's the fat part at the bottom that you eat. It's the sort that you cook, that I'm talking about.

356. H. It's on there. You can see that line on there.

357. R. Mm. But you've seen other things that you can eat growing, haven't you? Because you've told me about those? Right. Now the very last question is a really tricky one. So you need to think about this one. If the sun stopped shining, and so the plants could not grow any more, what would we eat?

358. H. [Long pause]. Some leaves.

359. R. Well, in a little while. In a week or two, even the leaves would die. Wouldn't they? And then what would we do?

360. H. Do you eat the things from the animals?

361. R. We could eat meat, still. Couldn't we? But what about the animals? What would they eat?

362. H. Grass.

363. R. But it's died.

364. H. Mm. Would everything that would grow, like the plants, would have died?

365. R. If there was no sunshine. You've probably grown things in a dark cupboard, haven't you, and seen? They go all yellow, and then they die. So what would we do for food if the sun stopped shining, permanently, and it was dark?

366. H. [Long pause] Eat the things that were still left in your house?

367. R. You would do that. I'm sure you would. Yes. And what would you do when you've finished eating those? Because they wouldn't last for very long, would they?

368. H. Mm. [Long pause] Go to the shops and buy some more?

369. R. You would do that. But where would the shops get stuff from?

370. H. [Long pause].

371. R. Let's think about the different foods, and where it comes from. If the shops get it, they get it from where, basically?

372. H. They get it from what the animals have got. What the animals have got inside their bodies. That's what the people who deliver stuff to the shops give.

373. R. That's right. Yes. So if you go backwards, first of all, we go to the cupboard or the fridge. Then we go to the shops. The shops go to the farm for meat, don't they? And eggs. And, er, for vegetables, salad? [pause] It's farms as well, isn't it?

APPENDIX III: SPREAD-SHEETS OF DATA FROM SEMI-STRUCTURED CHILD INTERVIEWS

Key:

y = correct answer

o = question not asked

n = question asked, but correct answer not given.

Spread-sheet A: Data for children aged four (pages 321-325).

Spread-sheet B: Data for children aged six (pages 326-330).

Spread-sheet C: Data for children aged eight (pages 331-335).

A - Data for four-year-olds

Name	DOB	Age	Sex	School	Cook. experience	Cook with?	Eggs origin	Eggs evidence	Meat Types	Meat Origin	Milk/cow	Cheese Ident.
DD	18.11.92	4	m	M	puddings	Nanna	shop	o	meat	pig	y	cake
KT	09.04.93	4	f	M	n	o	y	n	chicken	n	y	y
RW	19.01.93	4	f	M	eggs	Mum	milkman	o	chicken	n	n	y
CA	29.09.92	4	f	M	o	o	farm/cow	o	n	n	y	y
CH	21.02.93	4	f	M	soup	Mum	Sainsbury's	o	chicken	n	Sainsbury's	y
PC	15.11.92	4	m	M	beans & sausages	Mum	birds (y)	o	meat	n	shop	y
BC	16.11.92	4	m	M	n	o	shop	o	bacon	shop	shop	y
EB	27.09.92	4	m	M	bread	Mum	y	teacher	meat	pig, cow	y	y
JF	26.02.93	4	m	M	n	o	shop	o	chicken, beef	n	shop	y
SL	04.09.92	4	f	M	wash dishes	Mum	cows	as does milk	chicken, lamb	pig	y	y
RG	17.03.93	4	m	M	n	o	frozen	o	meat	shop	y	y
KP	14.01.93	4	f	M	n	o	farms	grandparents	meat	factory	y	y
LM	04.02.93	4	m	M	n	o	y	book	pig's foot	n	y	y
LW	21.09.92	4	m	S	cakes	Mum	shop	o	n	o	shop	o
KA	02.02.93	4	f	S	Might burn	o	cluck, cluck	o	n	n	y	meat
SH	22.09.92	4	m	S	n	o	y	o	steak	n	y	y
SA	19.01.93	4	f	S	n	o	n	o	chicken	n	y	y
AB	03.11.92	4	f	S	washing up	Mum	y	TV	n	n	y	n
LG	20.11.92	4	m	S	washing up	Mum	y	farm	beef	cow	y	y
PM	11.09.92	4	m	S	help	Mum	y	they lay eggs	meat	turkey	y	butter
AS	12.11.92	4	m	S	with yoghurts	Mum	farmer	n	n	n	y	white stuff
JH	24.01.93	4	f	S	o	o	shop	o	meat	shop	shop	y
VS	15.09.92	4	f	S	n	o	y	live on farms	n	o	y	y
NS	05.01.93	4	f	S	Chips	Mum	shop	o	n	n	shop	n
RL	03.12.92	4	f	S	pastry/ice lollies	Mum	y	grandma	bacon	n	y	y
LH	14.04.93	4	f	M	cakes, mash potato	Mum	farm	o	meat	farm	y	y
SM	04.09.92	4	f	M	cookies	Mum	y	they lay them	n	o	y	y
IS	08.12.92	4	m	M	n	o	shop	o	pork	shop	Kwick Save	butter
AR	29.12.92	4	m	M	peel pots., cook eggs	Mum	y/ducks	farm	meat	n	y	y
SAB	21.10.92	4	f	M	cakes, spahetti hoops	Mum	y	because I do	lamb	baby sheep	y/ goats	y

A - Data for four-year-olds

Cheese from	Hens lay eggs	Hens eat	Because?	Farm visit?	Farm with	Seen Cows	Ident. udder	Seen milking
shop	y	seeds	like birds	y	friend	y	y	o
n	y	n	o	n	o	o	y	o
n	y	grass	o	n	o	n	n	o
n	y	eggs	o	n	o	o	n	o
n	n	n	o	n	o	n	y	n
factory	y	eggs, bread crumbs	eggs laid; bread cf. birds	y	parents	o	o	o
n	y	corn, grass	o	y	on holiday	y	y	y
mouse	y (teacher)	grass, seeds	Mum told me	y	o	y	y	y
n	o	worms	o	n	o	o	n	n
n	y (milk is like eggs)	hay	o	y	mum, granddad	y	y	o
n	y	eggs	o	y	o	o	n	o
n	y	bread, eggs	o	y	granddad, nanna	o	y	n
o	y (home book)	eggs	o	n	o	y	n	n
n	y	n	o	y	friend	y	y	n
n	y	grass/carrots	like horses	y	nursery	y	y	n
n	y	n	o	y	nursery	y	n	n
n	y	grass/hay	o	o	o	y	y	n
n	y	n	o	y	nursery	y	y	y
butter	y	grass	o	named farm	o	o	y	y
butter & jam	y	eggs that don't hatch	o	y	nursery	y	y	n
n	n	o	o	y	nursery	y	y	y
shop	give farmer food	all kinds	o	y	mum	y	n	n
n	y	hens' food	o	y	o	y	y	video
n	y	n	o	y	nursery	y	y	y
n	y	left-overs	o	"Grandma's"		y	y	n
n	n	chicken food	o	y	o	y	y	o
n	y (because they lay)	hen food	o	y	granddad, nanna	y	y	n
n	n	n	like birds	y	aunt's farm	y	n	n
n	y (seen them laid)	chicken food	o	y	o	y	y	y
o	y	seeds	seen them fed	y	mum, nanna	n	y	y

A - Data for four-year-olds

Seen where?	Eat grass	Cows also eat	Lettuce ident.	Lettuce orig.	Tomato orig.	Tom. seen growing	Chips from pots.	Pot. orig.	Seen growing?
o	y	hay	tree	o	n	o	o	o	o
o	milk	grass	leaves	o	n	o	n	o	o
o	y	n	n	greenhouse	fridge	o	n	n	o
o	milk	o	n	n	o	o	n	n	o
o	y	o	n	o	grow	n	y	n	o
o	y	n	y	shop	field	o	n	n	o
farm	y	n	n	shop	shop	o	n	shop	o
TV	y	o	cabbage	grow them	grow	n	y	grow	n
o	y	chickens	flowers	n	shop	o	n	n	o
o	y	hay	y	n	shop	o	white meat	n	o
o	y	n	leaves	grow them	shop	o	y	farm	n
o	y	o	cabbage	field	n	o	n	n	o
o	o	o	y	shop	n	o	y	n	o
o	y	n	n	shop	grow	Granddad	n	o	o
o	y	carrots	y	trees	o	o	y	o	o
o	y	don't know	cabbage	n	n	o	n	o	y Dad
o	y	hay	leaves	n	n	o	n	o	o
TV	y	n	salad	n	n	o	n	o	o
video	y	beef	cabbage	grow them	grow	greenhouse	y	n	o
o	y	n	y	n	tomato sauce	o	y	digged	n
farm	y	n	tree	make them	countryside	n	n	o	o
o	y	don't know	tree	shop	shop	o	shop	o	o
Fox & H. video	y	n	y	n	field	n	y	fields	book
farm (no ev.)	y	don't know	cabbage	shop/leaves	shop	o	n	o	o
video/U. Seymour	y	n	y	n	n	o	y	grow	o
o	y	hay	y	shop	shop	o	n	farm	o
o	y	n	cabbage	n	n	o	o	o	o
o	y	n	trees	shop	n	o	n	o	o
farm	y	hay	cabbage	n	n	o	n	n	o
TV	y	o	cabbage	n	n	o	y	n	o

A - Data for four-year-olds

Bread made from	Baking experience	Cornfl. ident.	Cornfl. orig.	Onions ident.	veg. seen growing	Whose veg?	Water	Soil	Sun	Anything else?
o	o	o	o	flowers	o	Nanna	y	o	o	o
n	o	n	o	n	gardens	o	n	o	o	o
n	o	n	n	y	onions, cauliflower	Granddad	y	o	o	o
n	o	n	o	n	o	o	y	y	o	o
o	o	o	shop	grass	n	o	o	o	o	o
n	o	y	n	grass	carrots	TV	o	o	o	o
n	o	n	n	grass	cress	o	y	o	o	o
flour, eggs, mix it	bread	y	cereal	y	y	Granddad	y	o	o	o
n	o	y	n	grass	o	o	o	o	o	o
n	o	y	n	grass	apples	o	y	y	o	o
n	o	y	n	leaves	n	o	y	y	o	o
n	o	y	n	n	n	o	y	o	o	o
n	o	y	n	n	n	o	y	n	o	o
n	cakes	y	n	n	lettuce/onions/tomatoes	Dad	y	o	o	o
n	cakes	breakfast	shop	n	n	o	y	y	n	o
n	o	y	n	y	onions/potatoes	Dad	n	y	o	o
o	o	crisps	n	leaves off trees	tomatoes	Granddad	n	y	o	o
n	n	y	n	n	tomatoes in nursery		y	y	o	plant food
mix it	cakes	y	n	leeks	lettuce/leeks	Grandad	y	n	n	o
n	y	y	wheat	grass	n	o	y	y	o	o
n	n	y	n	grows	n	o	n	o	o	o
n	cakes	y	shop	grass	n	o	y	o	o	boxed food
n	cakes	y	n	n	n	o	y	o	y	o
n	biscuits	y	n	n	radish	self	y	y	n	o
n	cakes	y	n	grass	carrot	o	y	o	n	o
pastry and crumbs	n	crisps	farm	grass	n	o	o	o	o	o
o	o	crisps	n	plants	carrots,strawberries	Nanna	y	y	o	o
n	o	n	n	plants	n	o	n	y	y	o
milk	o	y	corn	cabbages	tomatoes	o	y	o	o	o
flour, eggs, lard, water	cakes	y	n	n	corn	farm field	y	o	o	o

A - Data for four-year-olds

Remarks							
Difficulty keeping on task. Got up and started looking at some new books on the shelf.							
Asked me questions as a diversionary tactic, e.g. Do you know that lady with the flower jumper on? That's my Grandma.							
Shook head in response to most questions. Said they were too hard.							
Inappropriate response, e.g. Farmer keeps chickens because he likes them. Changed subject, e.g. At my house we've got a doggy.							
Made diversionary statements, e.g. those are some books in there in respnse to a question.							
Refused to answer some of the later questions, saying, I don't want to talk about it.							
Made diversionary statements, e.g. Do you like raspberries?							
Diversionary remarks, e.g. I've just seen a car.							
very chatty, with joky remarks, e.g. My guinea pig eats chocolate.							
Made a lot of irrelevant remarks							
Took me by the hand to see the tomato plants growing in the foyer							
Uncommunicative							
Changed the subject in response to some questions.							
Was silent in response to several questions.							

B - Data for six-year-olds

Name	D.O.B.	Age	Sex	School	Cook. experience	Cook with?	Eggs origin	Eggs evidence	Meat types	Meat origin	Milk/cow
AG	1909.9	6	f	S	wash up	o	y	n	turkey,chicken	o	y
MH	22.10.90	6	f	S	pastry/bolognese	mum	shops/factory	o	lambchop	o	factory
AJ	12.10.90	6	m	S	n	o	n	o	n	n	y/teacher
GB	22.06.91	6	m	S	rollpastry/scram.eggs	mum	y	TV	bacon/chicken/fish	dadshootsrabbits	y
RM	28.01.91	6	f	S	n	o	y	TV	chicken	o	y
GW	06.05.91	6	m	S	chips/breakfast	mum	y	Mum	n	o	y/dad
SB	20.04.91	6	f	S	toast	mum	shop	o	chicken	o	y/mum
AA	12.04.91	6	m	S	n	o	shop	o	n	o	y
CC	07.04.91	6	m	S	squeezeoranges	mum	y	farm	ham	o	y
LD	15.03.91	6	f	S	n	o	y	video	chicken/pork/turkey	n	y/schoolvideo
CF	01.09.90	6	f	S	bake cakes	mum	y	video/book	pork/bacon/beef	pig/cow/mum	y
KR	26.05.91	6	f	M	sausages/eggs	mum	shop	o	kidney	bakers/chickens	y
JC	19.12.90	6	m	M	bake cakes	mum	y	farm	chicken	birds	y
JJ	25.04.91	6	f	M	dinners/cakes	mum/dad	n	o	beef	cows	y
CJ	22.01.91	6	m	M	melted marshmallows	mum	y	TV	n/vegetarian	cow/chicken	y
SW	23.02.91	6	f	M	sausages/eggs/beans	mum	shops	o	chicken/turkey	o	y
AM	27.11.90	6	f	M	Yorkshire puddings	mum	shop	o	meat	n	y
LC	06.03.91	6	m	M	eggs,carrots	mum	y	I know	meat	pig/cow	y
SH	19.04.91	6	f	M	chicken/potato/beans	mum	y	sister	chicken	chickens	y
EL	21.03.91	6	f	M	eggs	nan	n	o	meat	men carry it	y
RS	04.04.91	6	m	M	sandwiches	mum	y	cartoon	pork/turkeychicken	pig	y
JA	12.05.91	6	m	M	n	o	n	o	meat	butcher	machine
ES	09.04.91	6	f	M	sultanacake/break/dinner	mum	shop	o	meat	n	y
RT	14.09.90	6	m	M	n	mum	y	seen hens	ham	n	y
GA	22.05.91	6	f	M	set table	mum	y	farm	meat	pig/cow	y
NWh	3.10.90	6	f	M	pizzas	mum	y	n	pork	pig/cow	y/g'dad
NWi	21.03.91	6	m	M	dippy eggs	mum	y	TV	steak/chicken	n	y
SC	20.02.91	6	m	M	grate cheese	mum	y	farm	chicken	o	y
EL	15.10.91	6	f	S	cakes	mum	y	mum/farm	pigchicken	pork/hen	y
JB	13.12.91	6	f	M	toast/serve dinner	mum	y	n	chicken/beef	n	y

B - Data for six-year-olds

Cheese from	Hens lay eggs	Hens eat	Because?	Farm with	Seen animals	Ident. udder	Seen milking	Seen where?	Eat grass
n	o	bread/corn	video	Family/school	y	y	y	Video	y
n	y	corn	TV	school/nanna	y	y	y	o	straw
n	n/eggs	own eggs	o	school/nursery	y	y	y	farm	y
pastry	y	chicken	dad has gun	school/parents	y	y	y	TV	y
n	o	worms	o	friend/school	y	y	y	farm/TV	y
n	y	grass	o	nan	y	y	y	farm	y
n	n	corn	seen at farm	school	y	y	n	o	y
n	n	crusts	n	n	n	y	y	TV	y
n	y	corn/water	seen at farm	dad'sfriendfarm	y	y	y	schoolvisit	y
n	y	bread	fedthem	nursery/Y1/nr.home	y	y	y	school/video	y
n	o	seeds/worms/corn	widlikethem	school	y	y	y	video	y
machine	y	eggs/seeds/bread	o	nr.home	y	y	calf feeding	field	y
n	y	hay/grass	o	friend	y	y	y	video	y
n	y	n	o	nanfriends	y	y	y	TV	y
milk/mum	o	corn	TV	n	n	y	y	TV	y
n	y	grass	o	cousins	y	y	y	Fox&HoundVideo	y
n	y	nuts	feedbirds	nan/school	y	y	y	TVCitySlickers	y
milk/TV	y	bread	o	nan	y	y	y	TV	y
n	y	meat	o	mum/aunt/uncle	y	y	y	TV	y
milk	y	grass/worms	likebirds	nan	y	y	y	TV/field	y
n	y	worms/spiders	n	playsch	y	y	y	TV	y
butter/mum	y	notslugs	o	o	o	y	y	TV	y
n	y	birdseed	haspetbird	uncleisfarmer	y	y	n	o	y
n	y	cabbage	o	o	o	y	n	o	y
n	y	hen food	o	neighbour	o	y	o	o	y
n	y	hen food/grass	o	o	y	y	n	o	y
n	y	n	o	parents	y	y	y	TVBlue Peter	y
n	y	bread/seeds	fedthem	nearby	y	y	y	TV	y
n	y	worms/eggs	likebirds	nearby	y	y	y	TV	y
n	y	straw	o	school/nearby	y	o	y	farm	o

B - Data for six-year-olds

Cows also eat	Lettuce origin	Tomato orig.	Tomato seen growing	Chips from pots.	Pot. orig.	Seen growing?	Tubers where?	Bread made from
n	seen growing	o	o	y	n	n	o	milk
o	shop/plant	o	n	y	grow	TV	bottom/plant	potato
n	n	n	o	n	o	o	o	n
own milk	field	shops	o	white stuff	o	o	o	o
n	n	trees	y	n	o	o	o	n
n	shop	trees	y	y	o	o	o	flour/TV
calfdrinksmilk	shop/grows	o	o	y	n	o	o	n
bread	garden/TV	o	o	y	n	o	o	o
straw	plant seeds	o	y	y	grow	n	o	o
cabbage/carrots	n	o	o	y	n	y	o	milk/flour
n	plants	trees	nan	y	field	y	n	pastry
o	Co-op	shop	o	straw	shop	o	o	whitebread
n	n	grow	o	y	n	o	o	n/butter
n	n	n	o	y	n	y	o	n/icing
carrots	grow/garden	grow	n	y	grow	y	underground	dough/mum
n	shop	trees	o	o	KwickSave	o	o	toaster
n	plant	n	n	y	seeds	o	o	n
n	shop	tree	greenhouse	n	grow	o	o	n
calf-milk	shop/machine	n	o	y	n	o	o	n
worms	shop	shop	o	y	o	TV	underground	n
hay	seeds	seeds	n	y	seeds	n	o	flour/rising/mum
o	n	trees	o	y	n	o	o	n
o	leaves	n	o	y	grow	y	o	n
o	n	n	o	n	n	o	o	n
o	n	grow	in a book	crisps	n	o	o	n
n	grow	grow	g'dad'sgreenhouse	y	seeds	o	under ground	flour/little redhen
n	grow	tree	o	n	n	o	o	n
n	field	tree	own garden	y	grow	y	n	corn
chicken	n	n	o	y	n	o	o	powder
o	n	grow	neighbour	y	n	o	o	white stuff

B - Data for six-year-olds

Baking experience	Cornfl. orig.	Onions ident.	Veg. seen growing	Whose veg?	Water	Soil	Sun	Sun why?	Anything else?
cakes	corn	turnips	neighbour	n	y	o	o	o	n
cakes	crispy	grass	n	o	y	y	y	o	o
o	n	n	pea/onion/carrot	home	y	o	o	o	n
o	wheat/corn	grass	n	o	y	o	o	o	n
cakes	n	n	lettuce	neighbour	y	o	y	warm	n
o	n	grass	field	o	y	y	o	o	n
n	n	plants	yard	mum	y	o	o	o	n
o	n	grass	n	o	y				n
o	n	y	corn/cabbage	n	y	y	o	o	n
bread/mum	n	y	onions/potatoes	g'dad	y	o	o	o	n
cakes	corn/name	y	cabbages/potato	farmfield/uncle	y	o	y	nan said	compost
o	straw	seeds	onions/cabbage!	dad	y	y	o	o	n
o	n	y	tomatoes	friend	y	o	o	o	salt
o	corn	radishes	radishes/potatoes!	neighbour	y	o	y	n	n
o	corn	y	cabbage/carrot	friend/classroom	y	o	y	growwell	n
o	crisps	grass	carrot/onion/bean	mum	y	o	y	helpgrow	o
cakes/biscuits/nan	n	n	carrot/pea	uncle	y	y	y	helpgrow	o
cakes	n	grass	apples	o	y	y	o	o	n
choc.crispies/cakes	n	green	cabbage!	o	y	o	o	o	n
cakes/biscuits/nan	n	grass	carrot/sprouts	o	y	o	y	o	air/school
o	corn	y	corn/cabbage/apple	classroom/neighbour	y	y	y	o	o
cakes/sandwiches	n	grass	n	o	y	o	o	o	n
chocolate cakes	corn/name	grass	corn/potatoes/carrots	field/neighbour	y	o	y	o	o
scones	n	leeks	leeks/potatoes	g'dad	y	o	y	n	o
cakes	n	grass/daffodils	onion	classroom	o	o	o	o	o
cakes	corn	y	onion/potato/carrot/cauli	g'dad/classroom	y	o	y	o	o
cakes/mum/dad	corn	n	corn/onion/cauliflower	fields/BluePeter	y	o	y	to grow	o
cakes	corn	y	potato/onion/cabbage		y	o	y	hot	o
cakes	crisps	y	onion	classroom	y	o	y	help grow	o
cakes	n	plants	n	o	y	y	o	o	n

B - Data for six-year-olds

No sun?
plants would die
o
n
o
n
o
o
o
o
shops
animals/meat/then nothing
o
o
o
o
o
o
o
o
water/nothing
nothing/we'ddie
o
shops
o
o
shop/garden/meat
o
make them
o
o

C - Data for eight-year-olds

Name	D.O.B.	Age	Sex	School	cook. experience	Cook with	Eggs origin	Eggs evidence	Meat types	Meat origin
JW	19.04.89	8	m	S	mashed potato	dad	y	farm/bird's nest	pork/ham	pig
CA	30.05.89	8	f	S	set table	mum	market/shop	o	ham	n
DA	04.09.88	8	m	S	drinks	mum	y	n	pork/beef	pig/cow
MA	08.02.89	8	m	S	scrambled eggsx1	mum	y	hatched/nursery	pork	pig/cow
JC	09.10.88	8	m	S	n	o	n	o	ham/pork	pig
CE	01.10.88	8	m	S	o	o	y	farm	lamb	cow
VM	27.05.89	8	f	S	soup/tea	nan	y	farm	pork/ham/lamb/chicken	pig
NR	15.04.89	8	f	S	wash dishes	mum	y	neighbour's allotment	meat	n
CS	04.03.89	8	f	S	veg. prep.	g'dad	n	o	meat	n
AS	18.05.89	8	m	S	sometimes	o	y	cartoon/g'dad's allotment	chicken/beef/pork	cow/pig
NM	05.10.88	8	m	S	n	o	n	o	pork/beef	pig/cow
LM	24.12.88	8	f	S	beans	mum	y	friend's allotment	pork/ham/chicken	pig
MM	28.10.88	8	f	M	beans	mum	shops/y	hens lay eggs	lamb	sheep/cow/pig
SE	16.12.88	8	f	M	prawnsalad/barbie dips	dad	y/farm	people told me/books	beef/chicken/duck	cow
JM	30.09.88	8	f	M	cakes	mum	y/&otherbirds	TVprogs & news	pork/turkey/chicken/beef	pig/cow
SM	03.03.89	8	f	M	beans	dad	y	n	lamb/pork	sheep/pig
MA	19.05.89	8	f	M	sandwiches/puddings	mum	y	books	chicken/turkey/lamb	sheep/cow/pig
MO	01.02.89	8	m	M	cakes/scones/biscuits	mum	y/farm	farm shop	pork/chicken	pig/cow
TO	01.02.89	8	m	M	scrambled eggs	mum	y	n	pork/beef/lamb/chicken	pig
KH	15.11.88	8	f	M	crisps in bowls	mum	y	n	lamb/beef/pork/chicken	cow/pig
KR	10.06.89	8	m	M	puddings/mashed potato	mum	y	sister told me	turkey/chicken/ham	n
LT	17.06.89	8	f	M	tuna sandwiches	mum	y	n	bacon/pork/chicken/beef	pig/cow
MW	06.06.89	8	f	M	washup/b'daybreakf.	mum	y	people told me	pork/lamb/bacon/chicken	pig/lamb chops
RC	02.06.89	8	f	M	baking cakes/sandwiches	mum	y	farmyard/hens	beef/pork/chicken	cow/lamb/pig
JAD	03.01.89	8	m	M	mince/eggs/pancakes	mum	y	farm	beef/lamb/pork/gammon	cow/sheep/pig
RH	19.03.89	8	f	M	o	o	y	mum/farm	beef/pork/lamb	cow/pig/sheep
SL	27.02.89	8	f	M	jellies	mum	farms/y	g'dad's farm	ham/bacon/chicken	pig
RJ	22.02.89	8	f	M	waffles/cakes	mum	y	o	lamb/pork	pig
LJ	23.09.88	8	f	M	toast/egg/bacon	mum	y	been shown	meat	lamb/pig
SS	23.12.88	8	m	M	toast/crumpets/picnic	mum	y	farm	pork/beef	pig/cow

C - Data for eight-year-olds

milk/cow	Cheese from	Hens lay eggs	Hens eat	because?	Farm with	Seen animals	Ident.udder	Seen milking	Seen where?
y	n	y	corn/meat	seen fed	parents	y/not school	y	y	farm
n	n	y	grass	o	dad	y/park	y	y	TV
y/book	y/TV/mum	y	bread/worms	o	holiday	y/not school	y	n	o
y	n	y	seeds/worms	seen birds	nursery	y	y	y	TV
y	y/TV	y	worms	o	school	y	y	y	TV
y	n	y	grass/worms/corn	TV/mum/dad	dad's work	y	stomach	y	farm
y	pastry	y	seeds	seen fed	dad	y	y	n	o
y/nan	n	o	corn	o	o	o	y	y	TV/Playbus
y/mum	butter	y	eggs,not own/grass	o	n	o	y	y	TV
y	n	o	grass	guess	o	y	y	y	TV
y	y	y	hay/straw	o	parents	y	y	y	farm/helped
y/TV	y/guess	y	bread/worms	birds	o	o	y	o	o
y	n	y	corn/grass	seen farmer	school/mum	y	y	o	describeslesson
y	y	y	little grains of corn	seen farmer	o	y	y	o	describeslesson
y/lesson	y	y	littleseeds/worms/plant	seen farmer	friend's farm	y	y	y	farm
y	n	y	n	o	school	y	y	y	TV
y	n	y	n/little animals/grass	o	schoolx2/parentsx3	y	y	o	o
y	butter	y	grass	like birds	y	y	y	o	o
y	butter?	y	grass/seeds	seen pecking	uncle	y	y	n	o
y	y/TV	y	corn	o	y	y	y	y	TV
y	n	y	corn	guessed	n	cows from car	y	n	o
y	y	y	corn	fed them	parents/not school	y	y	o	o
y	y/butter	y	corn/small animals?	fed/guessed	parents/not school	y	y	o	o
y	y	y	seeds	fed them	school	y	y	o	o
y	y	y	grain	fed them	holiday on farm	y	y	y	farm
y	y & flour	y	grains	fed them	school	y	y	y	o
y	n/later y	y	nuts	guess	school	y	y	y	farm
y	n	y	cheese	guess	school	y	y	n	o
y	y & water	y	corn	video	parents	y	y	y	farm
y	y & flour?	y	o	o	school/holiday	y	y	y	TV

C - Data for eight-year-olds

Eat grass	Cows also eat	Lettuce origin	Tomato orig.	Seen growing?	Chips-potato	Pot. origin	Pot. seen growing?	Tubers where?
y	meat/corn(fed)	n	grow	dad's greenhouse	y	grow	n	n
y	n	n	n	n	n	n	o	o
y	n	grow	seeds	dad's greenhouse	y	grow	TV	root
y	corn	seeds	seeds	o	y	seeds	n	root
y	n	n	grow	o	y	out of ground	n	o
y	hay	out of ground	grow	g'dad's greenhous	y	out of ground	y/dad/mum	o
y	sweets/chocolate	gardens	grow	y	y	farm	y	ground
y	n	n	tree	y	y	n	y	n
y	n	garden	n	n	y	n	o	o
y	n	n	garden	g'dad's greenhous	y	n	o	o
y	straw	gardens	n	o	y	o	o	n
y	n	fields	grow	own greenhouse	y	fields	friend's garden	root
y	cow food	veg. patch	seeds	dad's greenhouse	y	seeds	dad's garden	n
y	n	grow/book/teacher/parent	o	neighbour	y	o	book/teachers/parents	ground
y	plants	grow in gardens	grow	g'dad	y	grow	g'dad	o
y	leaves	n	plants	o	y	plants	dad's garden	on a stalk
y	n	farm/plant/seeds	grow	o	y	plants	y	ground
y	biscuits	the soil	grow	fields	y	grow	y	under ground
y	n	grow	o	o	y	America	o	o
n	o	gardens	n	o	o	n	o	o
y	n	leaves	tree	o	y	n	o	o
y	n	grow	grow	o	y	grow/guessed	n	o
y	n	grows in fields	tall plants	o	y	grow in fields	n	at bottom
y	n	garden	grow	dad outside	y	garden	not seeds	under ground
y	nettles	grow	grown	grown by himself	y	helped grow	little round things	dig them out
y	hay	grow	grow	mum's garden	y	n	o	o
y	hay	grow	grow	g'dad's allotment	y	o	o	o
y	n	grow	n	o	y	n	n	n
y	n	grow	grow	o	y	n	n	o
y	n	Sainsbury's/seeds	grow	family greenhouse	y	little potato	grown himself	under soil

C - Data for eight-year-olds

Anything else?	No sun?	
n	water them	
n	shops	
n	n	
n	We'd die	
o	birds/animals/we'd die	
plant food	fridge/shops/starve	
n	we'd die	
n	n	
n	o	
n	n	
n	n	
n	grow them in the house	
o	watertomakethemgrow/bananas/crisps	
o	meat/we'd starve	
n	meat/erm/we'd not have much	
n	we wouldn't have any food	
n	meat/cheese/we would die	
n	n	
o	meat/don't know	
o	n/can't guess	
n	n	
o	we would drink water	
n	wouldn't get much at all/plantsdie/milk	
liquid feed	grow it/don't know	
manure	they'd die/processed food/meat/starve	
oxygen	leaves/things from animals/shop/	
n	shop/market garden	
n	we'd starve	
o	just have watershop/	
fishbone&blood	meat/they would die/there would be nothing living on the earth	

APPENDIX IV: SCORES FROM SEMI-STRUCTURED CHILD INTERVIEWS

Scores for four-year-olds - page 337.

Scores for six-year-olds - page 338.

Scores for eight-year-olds - page 339.

Scores for four-year-olds

Child Initials	DD	KT	RW	CA	CH	PC	BC	EB	JF	SL	RG	KP	LM	LW	KA	SH	SA	AB	LG	PM	AS	JH	VS	NS	RL	LH	SM	IS	AR	SB
School	M	M	M	M	M	M	M	M	M	M	M	M	M	S	S	S	S	S	S	S	S	S	S	S	S	M	M	M	M	M
Sex	m	f	f	f	f	m	m	m	m	f	m	f	m	m	f	m	f	f	m	m	m	f	f	f	f	f	f	m	m	f
Egg orig. pic.	0	1	0	1	0	1	0	1	0	0	0	1	1	0	0	1	0	1	1	1	1	0	1	0	1	1	1	0	1	1
Meat animal	1	1	1	0	1	0	0	1	1	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
Cheese milk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hen food	1	0	1	0	0	1	1	1	1	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1
Ident. udder	1	1	0	0	1	0	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1
Lettuce grow	0	0	1	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Tomato grow	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0
Chips potato	0	0	0	0	1	0	0	1	0	0	1	0	1	0	1	0	0	0	1	1	0	0	1	0	1	0	0	0	0	1
Bread flour	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
C'flake cereals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Seedling water	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	0	1	0	1	1
Seedling soil	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	1	0	0	0	1	0	0	1	1	0	0
Seedling sun	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Total	4	3	4	4	4	3	3	9	3	5	4	5	4	3	6	2	4	4	8	6	3	1	6	4	5	2	4	2	5	7

Scores for six-year-olds

Child Initials	AG	MH	AJ	GB	RM	GW	SB	AA	CC	LD	CF	KR	JC	JJ	CJ	SW	AM	LC	SH	EL	RS	JA	ES	RT	GA	NWh	NWi	SC	EL	JB
School	S	S	S	S	S	S	S	S	S	S	S	M	M	M	M	M	M	M	M	S	M	M	M	M	M	M	M	M	M	M
Sex	f	f	m	m	f	m	f	m	m	f	f	f	m	f	m	f	f	m	f	f	m	m	f	m	f	f	m	m	f	f
Egg orig. pic.	1	0	0	1	1	1	0	0	1	1	1	0	1	0	1	0	0	1	1	0	1	0	0	1	1	1	1	1	1	1
Meat animal	1	1	0	1	1	0	1	0	0	1	1	1	1	1	1	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1
Cheese milk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Hen food	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ident. udder	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Lettuce grow	1	1	0	1	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	0	1	1	1	0	0	1	1	1	0	0
Tomato grow	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1	1	0	1	0	0	1	1	0	0	1	1	1	0	1	1
Chips potato	1	1	0	0	0	1	1	1	1	1	1	0	1	1	1	0	1	0	1	1	1	1	1	0	0	1	0	1	1	1
Bread flour	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0
C'flake cereals	1	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0
Seedling water	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Seedling soil	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1
Seedling sun	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	0	0	1	1	0	1	1	0	1	1	1	1	0
Total	8	8	2	7	7	8	6	5	7	7	#	5	7	6	11	6	7	8	6	6	12	6	7	5	5	11	9	11	7	7
Without plants	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0

Scores for eight-year-olds

Child Initials	JW	CA	DA	MA	JC	CE	VM	NR	CS	AS	NM	LM	MM	SE	JM	SM	AM	MO	TO	KH	KR	LT	MW	RC	AD	RH	SL	RJ	LJ	SS
School	S	S	S	S	S	S	S	S	S	S	S	S	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Sex	m	f	m	m	m	m	f	f	f	m	m	f	f	f	f	f	f	m	m	f	m	f	f	f	m	f	f	f	f	m
Egg orig. pic.	1	0	1	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Meat animal	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	
Cheese milk	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	1	0	1	1	1	1	1	1	0	1	
Hen food	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
Ident. udder	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Lettuce grow	0	0	1	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	
Tomato grow	1	0	1	1	1	1	1	1	0	1	0	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	
Chips potato	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	
Bread flour	0	0	0	1	0	0	1	0	0	0	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	
C'flake cereals	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Seedling water	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Seedling soil	0	1	1	0	0	0	1	0	0	1	1	1	1	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0	1	
Seedling sun	0	0	1	1	1	0	0	1	0	0	0	0	1	1	0	1	1	1	1	1	0	1	1	1	1	0	0	0	1	
Total	8	4	12	11	8	8	11	8	6	9	10	10	12	12	12	9	11	12	9	10	9	13	13	12	12	11	10	8	12	
Without plants	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	0	1	0	

APPENDIX V: THE PARENT DIARIES

INITIAL INSTRUCTION PAGE

THE DIARY

Please keep a diary of what your child is learning about food:

- Conversations you have about food
- Questions your child asks about food and the answers you give

Please record the dates in the margin.

Your tasks are:

1. Note in the diary any trips you make to the countryside and what your child sees.
2. Choose a typical weekend and write down everything your child eats and drinks.
3. If your child helps you prepare food, choose one occasion and make a tape of the conversation which takes place. A blank tape is provided.

DIARY SCHEDULE

Year	Specific requests		
1	June <ul style="list-style-type: none"> ◦ What child sees on trips to the countryside ◦ Everything child eats and drinks over a typical weekend ◦ Tape-record a food preparations session with child 	October <ul style="list-style-type: none"> ◦ Titles of all books read to child over one week ◦ Computer programmes used ◦ Trips to museums and other places of interest 	March <ul style="list-style-type: none"> ◦ All food eaten over one weekend ◦ Trips to the countryside, especially to see young animals ◦ TV programmes watched over one week
2	June <ul style="list-style-type: none"> ◦ Experiences of planting: seeds, cuttings etc. and picking things which have grown: flowers, herbs, fruit etc. ◦ New experiences and visits to places of interest, holidays ◦ Child's favourite interests and pastimes 	October <ul style="list-style-type: none"> ◦ The most important ways child has developed since starting primary school a year ago ◦ Visits to new places, especially museums ◦ Parents hobbies and involvement of child 	March <ul style="list-style-type: none"> ◦ Any new experiences as a result of the very cold weather ◦ Titles of comics read ◦ Experiences of young animals and growing plants
3	June <ul style="list-style-type: none"> ◦ What child sees on trips to the countryside ◦ Has the recent BSE scare changed the eating habits of the family? ◦ Has it been the subject of discussion with child? 	February <ul style="list-style-type: none"> ◦ All child's food and drink over a weekend ◦ Child's main interests and hobbies ◦ Tape-record a food preparation session 	

APPENDIX VI: A PARENT DIARY

Edited version of a parent diary to show an example of items relevant to the thesis

Daniel Date of birth 30.4.1990

Parents' Occupations: Mother - Valuer for estate agent, Father - Weaver.

Year 1

Tonight we go on holiday to Ibiza. Daniel had soup for lunch, but picked at his tea of fish and chips. He was too excited to eat. Unfortunately Daniel was asleep when the in-flight meal was given.

There is an excellent selection of food for breakfast and evening meal. Daniel is being very choosy. So far this week he has had corn flakes without milk and fresh orange juice for breakfast. He will not even have the baked beans because he says they are not like the ones you get at home!

The evening meal has a variety of meat, fish, pasta, vegetables, and salad dishes. Daniel so far this week has had the soup (with a lot of bribery) and has tried the spaghetti and ravioli. Because of the heat he has drunk a lot of bottled water and Ribena.

Coming to the end of our holiday I have been worried about Daniel's lack of appetite. He is very reluctant to try any of the dishes available at meal times, even though we take him to see the food before putting it on a plate. Soup seems to be the only hot meal he will try. Ice cream and fresh fruit is the favourite sweet this week.

On our last day we took Daniel to a restaurant for lunch. He decided to order beans on toast with two slices of toast and what looked like a whole tin of beans. He promptly sat and ate most of what was on his plate! It must be the thought of going home. During this last week we had taken Daniel to several restaurants and he had attempted to eat a variety of pizzas, probably because they were covered in garlic!

We have been home for a week now and Daniel is eating us all out of house and home. He has been asking for his favourite lunches: tomato soup and tinned spaghetti bolognese.

During the summer holidays and nursery days Daniel spends Wednesdays with his nanna and granddad. With myself being at work full time, he arrives at about 8.30 am. when he has a bowl of porridge with All Bran. Lunch consists of a sandwich or bowl of soup with brown bread. His favourite tea is always pancakes with potatoes and gravy.

Daniel starts school today, and school dinners.

Daniel is enjoying his school dinners. He has had: pizza, chips, sausages and beans, meat pie and vegetables, ravioli, cake and custard, crispy cakes, yoghurt, fresh fruit.

Daniel's eating habits have improved tremendously. He will now try a variety of foods and will sit down and eat a full meal. His firm favourites are still an Italian mix of pasta, pizza and garlic bread with Mac Donald's being a special treat.

Food eaten during one weekend

Friday Breakfast

Corn flakes without milk, toast with Flora and marmalade.

Lunch

Beans and sausages with toast, a glass of milk, yoghurt.

Dinner

Turkey aeroplanes with chips and peas.

Supper

Milk and biscuit.

Saturday Breakfast

Frosties without milk, toast with Flora and marmalade.

Lunch

Mac Donald's

Dinner

Tortellini pasta in ragu sauce with salad and garlic bread.

Supper

Milk and biscuit.

Sunday

Breakfast

Porridge, glass of fruit juice.

Lunch

Chicken, potatoes, vegetables, Yorkshire pudding.

Tea

Ham sandwich, crisps, Swiss roll, drink of orange.

For the 18 months before Daniel started primary school he had an imaginary friend called Adam.

November

Daniel is progressing very well at school and brings home at least two books a week to read, as well as homework (writing and numbers).

Favourite books

Daniel read with his parents this week:

The Hairy Hat Man's House

Elephant Walk

Dippy Duck Dresses Up.

Don't You Laugh at Me!

The Baby-sitters.

He receives a star every week for his reading. He is learning the Letterland letters very well. Daniel is very imaginative. After hearing the story read he can recite it back. He can also make up his own story from the pictures. These are sometimes quite fascinating and far-fetched.

October Half Term holiday

Visited the Hancock Museum, Newcastle, with Gran to see the dinosaur display. He was still talking about it at Christmas. He was fascinated at the size of the dinosaurs and the noises they made. He can distinguish between a long neck and a Stegosaurus! He asked lots of questions about where and when dinosaurs were alive and what happened to them. We have bought models from the Early Learning Centre. He carried them around with him everywhere.

Daniel has been discussing food at school and what things need to grow. He has grown some cress and brought it home. He explained that it needs water and sunlight to grow. He has also baked a bread mouse at school. They have made mince pies, but Daniel (still a fussy eater) said he didn't like them. The school seems to be preparing the children for Christmas Dinner.

Daniel helped his mum to make mincemeat. He knew all the ingredients but was most disgusted at the finished 'look'. He has taken a dislike to dried fruit without even tasting it.

A hyper-active and exciting week. Daniel wants to know how Santa is going to get a bike down the chimney when we have a gas fire at the bottom! Not an easy question to answer. Also, how do the reindeer stay in the air when Santa brings the toys? How can Santa fit down the chimney when he is so fat? How does Santa know what he wants? He didn't stop talking. Since the school Christmas concert he has been singing all the songs and pretending to be a snowflake.

Christmas dinner. Daniel would not eat any prawns or mushrooms for starter, but did eat quite a lot of the main course, especially turkey.

A new baby is expected in the family on Easter Monday. Once Christmas was over, this was discussed with Daniel. He is looking forward to this a lot. He seems to have grown up a lot - possibly the thought of having someone younger to play with. He has promised to be a very good boy and has offered to change nappies and look after the baby. He did announce one day that at least he would have someone to play with when we went back to Ibiza. We had not discussed a holiday! It is amazing how much he can still remember about the holiday last July.

The dreaded questions have been asked since the bulge started to show, i.e. how did the baby get into Mummy's tummy and how does it get out. Will the Easter Bunny bring the baby? He is convinced he can hear the baby cry when he puts his head to his mummy's tummy. He wanted to know what sort of food the baby eats.

He has realised his responsibilities in the house. He tidies up more because he knows his mum can't bend down very well. He keeps his bedroom very tidy without being told and he has been praised a lot for this.

Daniel is progressing even better than expected at school. He settled down very well. He enjoyed the trip to the theatre, and so he has been taken to the pictures by his mum twice since. He talked about the films a lot afterwards. 'The Lion King' was about wild animals, one of Daniel's interests.

Lately Daniel has been telling his family about the lion, tiger and bats that apparently live in the garden. One morning he announced that he hadn't slept very well because of all the noise in the garden. He said that a bat had been knocking at the window. He went into his parents' bedroom in the night when this happened, but they were asleep and he didn't want to wake them up. So he opened the front door and there were a lion and a tiger fighting in the garden. After he had told them off he went back to bed. A few days later he told his Granddad that there was a broken window. After work his granddad enquired if the window had been fixed. When Daniel was asked about this he said that the bat had broken the window by knocking on it. After living with Adam, Daniel's imaginary friend, this did not seem too unusual!

Daniel can write his name, albeit using two hands. He has not yet developed hand dominance. He loves books and drawing. He sits at his desk for an hour at a time looking at books and drawing. This week he has read:

Screech, A Birthday Party, The Cow in the Hole, The Space Monster, Jack and the Giant, The Whale, Are You a Ladybird?

He visits the local library regularly where he gets two books each time.

My second child is due around Easter and I have now finished work. This means I can spend more time with Daniel.

I have a routine by picking up and taking Daniel to school and I have come into contact with other parents. It seems their children are just as fussy with food as Daniel, so much so that I notice a lot actually take packed lunches. However I don't think Daniel would get the vitamins and protein he needs. Tea time is the usual chaos with Daniel wanting spaghetti or tomato soup.

Sarah was born on April 14th. I am feeding her myself - the start of many questions from Daniel:

Where does the milk come from?

What does it taste like?

He is fascinated with everything about her and seems to have grown up suddenly. He is very helpful and takes time to amuse her and help with bath time.

Daniel doesn't have a lot of close contact with animals. We only have a budgie for a pet. On our daily trips to school we do stop to see a goat which he talks to and strokes and seems to have no fear. He is frightened of dogs and will walk away from an oncoming dog, a fear I think he picks up from me.

Sunday.

Daniel spent today with my brother and his four pet dogs and ferret. He spent 3 hours walking in the woods looking for rabbits. He was quite happy in the company of these dogs as he knew they belonged to his uncle.

Today Daniel went to Hall Hill Farm at Lanchester with his grandparents. He loves to see the young animals and has no hesitation in stroking them. After a tractor ride and picnic he came back very tired.

On several occasions we take Daniel to the pets at Home Store at the Arnison Centre. This is a good place for him to see family pets close at hand. He is particularly interested in the fish tanks and always remarks on the different colours.

We also have two young bats that fly around the front of the house. He seems to take a great interest in all types of animals and these are shown in his drawings and many tales he makes up. We still apparently have a lion and fox in our garden that come out during the night and make such a noise he has to get up and tell them to be quiet!

Year 2

Daniel is still being very fussy with his food. My attempts at trying him with something different has resulted in him being cautious about what I put in front of him. Still his favourites are Heinz spaghetti in any shape or form with toast being put separately on the plate. He still enjoys burgers and fish fingers and I have now started to grill everything. However, there must be no hint of anything burnt!

Television

Daniel would sit and watch TV all day if he could. He will watch most programmes. During the warmer months he tends to watch very little as he is outside. However, he does like to watch ITV which starts at 3.30 Tyne Tees.

Blue Peter 5.05 BBC1.

As I watch Coronation Street and East Enders, if he is still up he will watch these and can spot the characters in magazines. He watches Home And Away when he is at his childminder's. We do tape the odd programmes for him if these are on too late, such as The Crystal Maze. He is enthralled by this programme and will watch it several times. He enjoys all wildlife programmes. These are particularly good at the moment as it coincides with the work he is doing at school.

Daniel enjoys watching videos and has a small collection of Disney videos, e.g. Snow White, Beauty and the Beast, Jungle Book and the Aristocats. There are some good stories with songs that he can soon learn. He watches them over and over again.

Daniel has a good memory and good programmes will be remembered for months afterwards.

Daniel has enjoyed his first year at school. His knowledge of everyday things has grown tremendously. He is now beginning to take more notice of what is going on around him, and asking a lot of questions. He says he wants to go onto packed lunches after the school holidays because he doesn't like school dinners, but I am reluctant to let him do this as I think at least he is having a hot meal, and also I wouldn't know what to give him as he is so particular about what he eats!

We have taken the third and fourth week of the school holiday as our own holidays. The weather is wonderful and we have decided to spend the first week at home. We are spending as much time as possible in the garden enjoying the weather and Daniel has enjoyed each day as he has friends to play with.

We decided to spend the day at Beamish Open Air Museum. Arrived at 10.00 am. and the weather was very hot. We have brought a picnic and plenty of drinks. The baby has stayed with her Gran. today. We began by having a trip down the mine. Daniel wasn't too sure about this as it was very low and dark, but did ask lots of questions, i.e. what was the mine for, how did they get the coal out. He was quite shocked when I told him children used to work down the mine at his age! Daniel enjoyed looking at the miners' cottages as the gardens had pigeons and rabbits in. We travelled around the museum on the trams which he found fascinating. He wondered why we didn't have these in Durham. The next part of the museum was Pocklington Manor, a house of the period. We had to go twice to the pantry just to see the dead animals hanging up! He wouldn't taste the home-made bread that was on offer - typical really! The picnic wasn't much of a success either. He had a drink, a sausage roll and ham sandwich, but was more interested in running around the park. Towards the end of the day he was very tired, but thoroughly enjoyed it. I was pleased he took so much interest in the museum.

Daniel also spent a day at the Hancock Museum in Newcastle to see the insect show. He enjoyed this as it was associated with animals. He did say I wouldn't have enjoyed it because of the spiders.

The second part of our holidays was spent with my sister in Ashby de la Zuche in Leicestershire. The weather was hot again, so we travelled down at teatime. Daniel didn't stop singing and talking all the way there. While we were there we spent the day visiting Nottingham, and the castle where Robin Hood lived. Of course, Daniel had to ask a question which quite frankly neither of us could answer: Where is Robin Hood buried? He asked a lot of questions about Robin Hood and enjoyed walking around the castle, although the weather was very hot again.

We spent one day at the local swimming pool, which was an outdoor one. Daniel's confidence is growing, and he could swim on his own once he got used to the water. We have spent a lot of time in the garden this summer because I have been planting quite a few new plants and seeds and also grown some tomatoes in the greenhouse we have at Daniel's Gran's. Unfortunately, these have not done too well this year, much to Daniel's disappointment. He helped to plant them and was looking forward to picking them. He has taken a lot of interest in growing these and knew once the flowers appeared on the plants that the tomatoes would soon follow.

Daniel has gone back to school and is now in Year One with the same teacher as last year. He looked forward to going back.

This term seems to be a little harder for Daniel, and he is finding it a little difficult to keep up with the work. He is still undecided as to which hand to use to write with which means his pencil control is not too good. Although he is very good with the alphabet he can not distinguish the sounds and this is causing some confusion. I still believe this has something to do with his speech therapy lessons. It took Daniel some time to say certain letters.

He is still bringing plenty of reading books home, however, and spends a lot of time at home reading books and making up stories from the pictures.

Daniel's eating habits have become a little better of late. In fact he has eaten just about everything we put in front of him. We have cut out all snacks, biscuits, crisps etc. and I think this may have helped. He enjoys his spaghetti still. It may have something to do with the fact that his baby sister can now eat this as well! Breakfast is still cereal with no milk; or porridge. But he prefers fresh orange juice instead of milk. Daniel has not yet had a hot drink, and is reluctant to try.

We do spend the occasional Sunday baking, and Daniel enjoys helping with this. He always asks what the ingredients are and enjoys licking the bowl out at the end.

Daniel still enjoys eating out. Fish and chips, pizza and Mac Donald's are the favourite.

I would not say Daniel had a 'hobby'. He has enjoyed riding his bike over the summer. He could not do this when he got the bike at Christmas, but over the holiday period he has built up his confidence and now rides it to school every day. He still enjoys drawing and colouring, especially now he has his sister to do this for. He can spend hours playing with Action Man and his make-believe is very interesting.

Since his sister was born Daniel has been very protective of her. He always helps to get her ready each night and I usually put them both in the bath together. He has a knack of keeping her occupied, and when she is upset he will sing and dance just to make her laugh. At a wedding we recently attended he was left in charge of three children, to keep them entertained. He coped very well with this. People commented on how patient he was and how he kept the smaller children quiet. He is very thoughtful and always shares his toys with his sister.

Daniel is very interested in animals and this month he has watched a lot of animal programmes, mainly documentaries about wildlife. He takes great interest in these programmes and watches them several times. He likes to know the names of the animals, why certain animals change colour, why do they eat insects, where do they live, etc. He is very interested in Animal Hospital and even enjoys the operation part of the programme (not that I can watch this part!). I have told his teacher this at school in the hope that they can somehow bring this into the learning procedure.

Since Daniel started school a year ago he has come on in leaps and bounds. Daniel has always been a fairly quiet child with a reluctance to join in conversations or activities with people he did not know. However, since he started school he has become more confident in himself and therefore not frightened to join in conversations or ask questions. I do feel however that if Daniel had not been to play school when he was three and then on to Nursery before attending school he might not have been so confident. With attending the play school and nursery he has made friends and has been with them through each class.

Before Daniel started school he could not write his name or any letters at all, and I found it very difficult to keep his attention long enough to try and teach him. After only a few weeks at school he came home and could write his own name. The only difficulties he has had were that he could not decide which hand to use when writing. Consequently anything that was written on the left hand side of the page was written with the left hand and on the right side with the right hand. He therefore had difficulty distinguishing the letters 'b' and 'd'. In the first six months he also had difficulty saying certain words, anything that began with 's' and 'f'. However, an intense six week course at speech therapy soon sorted that out. Daniel was very self conscious at these classes and it took a few lessons before he actually spoke.

Throughout his first school year he has always had school dinners. Because he was such a poor eater at home I thought this might encourage him to try different foods. This seems to have worked a little bit. Daniel has fits and starts when it comes to food. Some weeks he will eat everything given to him. Other weeks he is fussy and won't eat anything. He does, however, seem to eat his school meals and even has stars for a 'clean plate'. Unfortunately sometimes he won't eat the same food at home because 'it doesn't taste the same'.

Daniel says he enjoys P.E., art, singing and story time at school. Certainly with P.E. he has become more agile and interested in sports activities.

He thoroughly enjoys singing. Even from play school Daniel has enjoyed singing and can remember the words to the songs quite quickly. We always hear the songs well in advance of any concert, and he is not afraid to stand in the choir and sing in front of an audience. Stories and books have always been a firm favourite with Daniel. He is only just now (January 1996) beginning to actually read words from a book, but ever since he could hold books he has enjoyed the pictures and can make up his own stories from them. He will read over and over again anything to do with animals.

Since I last wrote these notes we have not visited any museums since Beamish. At Christmas we had a couple of trips to Newcastle to shop and he enjoyed 'Fenwick's' window with all the moving characters. Unfortunately Daniel doesn't enjoy shopping that much!

My hobbies are mainly gardening, although this is somewhat restricted in the winter. However, during the summer months Daniel helped a lot by collecting the grass after it was cut, hoeing and planting new plants. He has always taken an interest in watching these grow and flower and feels quite proud to see them develop after he has planted them. Once the warmer months come Daniel would rather be outside than in and is fascinated with spiders, worms etc.

However, now in my spare time, which isn't a lot when working full time, is spent with Sarah, who is now 9 months old. Daniel has been a wonderful brother to her, so far. He is very patient with her, helps to feed her and will play with her and keep her occupied even though she does pull his hair and seems to want everything he has. Now that she is crawling she has become much more of a playmate to him. He builds the blocks up for her, teaches her to count, plays videos and tells her about them. He makes a 'den' between the chairs and they both sit in it and play quite happily. Sarah's personality will be quite different from Daniel's, I think. She is bad tempered, and seems to have achieved things much quicker than Daniel did at the same age. She seems to want her own way a lot and when she wants something will try hard until she gets it. But we will have to see when she gets a bit older.

Daniel is becoming excited at the prospect of Christmas.

The Christmas concert was very good. Daniel was dressed all in white with a tinsel head band. He sang very well.

They both got plenty for Christmas and we had a few good days. Sarah definitely ate more on Christmas day than Daniel. In fact she never stopped! He enjoyed opening two sets of presents as Sarah held onto one present most of the morning.

Back to school. Daniel has a new teacher now, Mrs. R. He says she is very nice, and he has to work hard. He is also now in Mrs. A's. class, which is an extra class for his letter work as he is a little behind with his letter and number work. This hasn't worried Daniel a great deal. He just seems to be getting on with it.

We are still having trouble with Daniel's eating habits. Sunday dinner now takes an average of half an hour to eat. He thinks I am cruel because I give him vegetables to eat.

Today we baked some cakes. Daniel helped mix the ingredients. He put some mixture in the bun cases. He licked the bowl, out, which I am sure is why he helps. Then he put the icing on with the decorations. He proceeded to eat several cakes afterwards!

Daniel has been complaining that his eyes hurt. He seems to be blinking a lot. We went to the optician's for an eye test. He has good eyesight, but has an infection. Another trip to the doctor's is needed.

These months have been very cold with a lot of snow. This has made it very difficult for us on a morning getting to the child minder's and school.

A lot of snow today. It was very cold but we had a laugh trying to get Sarah up to Framwellgate Moor in the pushchair. It took both me and Daniel to drag the pushchair backwards up the road. We were both very tired when we got to Aunty Janet's.

We decided after yesterday's trip we would get the bus up to Framwellgate Moor. Daniel wasn't too keen when we realised how full and wet it was. Everybody had made the same decision. He decided we would walk the next day.

Half term holiday has arrived again. Unfortunately I have to work. Daniel has decided he will stay with his nana and granddad for a few days. This ended up being a week, as his cousins also stayed. He spent the week going for long walks through the woods and along by the river. He came home on Sunday and said he had missed Sarah.

Since staying with nana and granddad he now has porridge every morning for breakfast! He seems to be enjoying his meals at the moment.

Daniel has also developed an interest in birds. We have hung some nuts on the tree in the garden and he sits and watches the birds through his binoculars. He then looks in his bird book to find out the species.

Today we planted some seeds. Tomatoes and flowers. Daniel helped put the compost into the pots and put the seeds in and water them. Hopefully these will grow!

A very busy month. Two birthdays to cater for. Daniel is looking forward to Sarah's birthday. He says we should have a party for her, so this is what we are going to do.

Sarah's first birthday. Daniel was up at the crack of dawn with her presents. She was still fast asleep! Daniel is a very loving brother. He explains to Sarah what her birthday is all about. He does however enjoy opening the presents. Sarah is not too well today. She has just come out of hospital after having an asthma attack. She has timed everything the same as Daniel - he was in hospital just before his first birthday as well.

Daniel helped to make tea for the party. We made sandwiches which had to be ham salad, the only sandwiches he will eat. We made fairy cakes, sausages on sticks, and sausage rolls. We had crisps, jelly and lots of wine for the adults. It was more of a celebration with Sarah coming out of hospital. All the family came over and it was a nice day. Daniel thoroughly enjoyed it and is now looking forward to his own birthday in a fortnight.

Daniel is still fussy about what he eats. I think I have come to the conclusion that he is not going to be a big eater, as unless it's ham he is not interested. He says he eats everything at school, but I can't really believe him. Most of the things he has at school he doesn't usually eat. The only meal I think he enjoys is breakfast, although he does still insist on having no milk on cereals. Toast has to be a certain shade of brown, with not too much butter or marmalade on. We now have got Daniel to eat eggs. He now enjoys a boiled egg on a morning at the weekend, but he will not have them done any other way.

Daniel is counting the days until the six week holiday! As Sarah is now walking he has realised that she wants to be with him at all times. This is something he will have to get used to. She follows him everywhere. Unfortunately, she is also jealous. She doesn't like it if he comes to me for a cuddle. She then goes for his legs to bite him!

Daniel is enjoying school and comes home many times with stars on his hand for work well done. His special lessons with Mrs. A. have helped him a lot. He seems able to cope better with the other lessons and his homework.

Year 3

We have been trying to make Daniel sit down each Sunday and enjoy a Sunday dinner. He is doing quite well, but today he announced he wasn't going to eat beef in case he got Mad Cow Disease! After having a chat with him it seems that he has heard about this in the school playground. I have tried to explain to him that there is no danger in eating beef, but unfortunately it hasn't helped. He is taking much more of an interest in daily topics he hears on the news, especially anything to do with children or war.

Sport is taking up much of Daniel's spare time these days. He is a mad Sunderland supporter like his dad and enjoys sitting watching games on the television.

We are going on holiday to Anglesey in Wales. Daniel has been looking forward to this for weeks. We collected the car and set off today. We made up a picnic for the journey. He didn't eat much, he was probably too excited.

We had a lovely cottage for a week in Wales. We had a picnic on the way there. There was plenty to eat - the usual things - sandwiches, chicken, crisps, etc. but Daniel would only eat the ham from the sandwiches and crisps. He doesn't seem to be getting any better with his eating habits. Sarah, on the other hand, ate all she could get hold of.

There was a swimming pool at the cottage. It had water chutes and steps down. As there were never many people in the pool it was more like our own Jacuzzi! Daniel enjoyed lying on the steps with the water splashing over him. Sarah was a bit more nervous but nevertheless still went in. Daniel became much more confident with his swimming. I was pleased with this, as he is to take swimming lessons when he starts the new term.

The cottage is set in beautiful countryside near a farm. Sarah is fascinated with the dogs and cows that belong to the owners. She certainly is an animal lover.

We went to Bangor for the day. We decided to have a Mac Donald's for lunch. Unfortunately there wasn't one to be seen. We opted for Kentucky Fried Chicken. Sarah loved it but Daniel said it had a funny taste - typical!

Spent a day at Butterfly World. Thousands of butterflies flying around us. Sarah did her best to pick a few up. Daniel was fascinated with the different colours and markings. He said some of them looked as if they had eyes on their wings. He was more interested in the ant hill that was set up in a glass tank. He could

see ants carrying food. "How can something so tiny carry those pieces of food?" he asked. I couldn't really answer that one.

Back home after a week and three days.

Daniel has decided to spend the rest of the holiday staying at Gran's and Nana's houses so we won't see that much of him over the next few weeks.

Back to school. Daniel is looking forward to a new term at school, but is a bit apprehensive about his swimming lessons.

Daniel enjoyed his swimming lessons and is pleased he can now put his head under the water without spluttering.

He has a new teacher, Mrs. B, who he likes very much. I have seen much better work from Daniel this month. Things seem to have clicked with him and he seems much happier now that he can do the sums and his reading is very good.

He seems to be enjoying his school meals. He says the work is a lot harder. I think it must be as he sleeps all night until 7.30 - something we have not known since he was born!

Comics are something that Daniel reads only occasionally due to the fact that I personally think they are far too expensive for what they are inside. He often picks them up at the newsagent's and asks for one, such as the Power Rangers or The Lion King. The odd time he does buy the Beano. As he can't really read it all he never seems to be that bothered. He would rather spend money on Pogs or GoGos.

There is a party at Mac Donald's for Halloween and we have decided to go. Daniel was dressed up. Of course, when we got there it was very busy. Daniel decided to have a Happy Meal - mainly for the free toy. The meal consists of chips (the only chips he will eat), hamburger with no relish, and a drink. Daniel and his friend thought it would be better if we ate this sitting in the car as it was so noisy.

Bonfire Night. We went to Aykley Heads this year for the bonfire. It was very good. They have a fire designed on the Lambton Worm and Penshaw Monument. It was dreadful weather and we got very wet. The only thing on Daniel's mind was that we were going to get a hamburger! He also wanted to know why we had a Bonfire Night and how fireworks are made.

Christmas is nearing and Daniel is becoming very excited. Someone has told him that Santa Claus is just your Mum and Dad. He was very annoyed at this because he believes in Santa 100%. The main present he has asked for is a radio, so he can listen to the football match in peace in his bedroom. He is football mad at the minute, so much so that he can play with a balloon for hours, kicking it around the sitting room. He talks non stop about Sunderland and football.

This month we have had a few trips to the Metro Centre. Both Daniel and Sarah enjoy the bus trip and of course we visit Mac Donald's for lunch.

Daniel's favourite TV programmes are Street Sharks (cartoon), BBC children's programmes such as Blue Peter and Art Attack.

APPENDIX VII: PARENT QUESTIONNAIRE

CHILDREN'S LEARNING AT HOME PROJECT

Children say they learn a lot with their family. This questionnaire is to find out more.

Your child's name Date of birth

Do you tape any of your child's favourite TV programmes? If so, please name the three most favourite programmes that you tape:

- 1.
- 2.
- 3.

About how many times does he or she watch a programme before you wipe it off?
Please circle the correct answer: 0-5 6-10 11-50 More than 50

What are your child's three favourite videos?

- 1.
- 2.
- 3.

About how many times has he or she watched the most favourite one?

Please circle the correct answer: 0-5 6-10 11-50 More than 50

Did your child grow anything in the house or garden this summer? If so, please give a brief description:

Has your child been able to pick fruit or anything else you can eat this year? If so please say what it was and where it was growing:

Did your child get to see any farm animals this summer? If so, what are they, and where did he or she see them?

Does your child ask lots of questions? Please write about them on the back of this paper.

Please return the questionnaire to your child's teacher as soon as possible. Thank you.

APPENDIX VIII

Typescript of nursery cooking session

It must be noted that the children said much more than is recorded here, because as it was such a large group many of their sayings were not picked up by the microphone. The teacher also, when speaking to individual children rather than the whole group, could not always be heard. The whole recording lasted one hour, and in addition, there were a few minutes at the end of the afternoon, when the children were given cooked biscuits to taste or take home.. There were eighteen children: ten girls and eight boys, although the session had only sixteen at any one time. All names have been changed for the purpose of confidentiality.

Teacher - T

Child - C

Jane, Rebecca, Stephanie, Christopher, Susan, Tom, James, Jemma, Darren, Kim, Adam, Jamie, Nathan, David, Vanessa, Julie, Christina, Lorin.

T. Now, are you listening? Are you looking at me? What do you have to do before you do any cooking at all? Before you do any cooking?

C. You have to pull your sleeves up.

T. That's one thing. There's something else. Something else that's very, very important.

C. I've got short ones!

C. I've got long ones!

T. Listen. Listen. Stephanie! Are you listening? What would happen if you made biscuits and you had just been out playing in the garden and then just came in and then you just came in and made the biscuits?

C. Muck.

T. So what do we have to do?

C. Wash them!

T. Mrs. Giles made these at home for the first time at home last night, and do you know, they didn't turn out very nice. they were very soggy. Let's hope we make nice crisp ones this time.

T. Now, before we make the biscuits we're going to look and see what we've got. Lets look at the ingredients first. Those are the things we put in to make the biscuits. The first thing we've got is this. What do you think we've got in here?

T. Let's start with the flour. Listen. What colour will it be?

C. White.

T. It might not be white!

C. Blue!

T. No!

C. Yellow!

T. Oh, yes, I have seen yellow flour. Whose mummy uses brown flour to make cakes?

C. Not me.

T. Who sometimes makes brown bread? Well.

C. Me! (chorus)

T. Right, hands down. Can you think what colour flour we use to make brown bread?

C. Brown flour!

T. Right. Well lets see what colour flour this is. Is it white flour, brown flour or yellow flour. We use yellow flour to make, erm, special cakes in Ireland. Can you tell me what colour this is?

C. White.

T. White. We use this flour to make biscuits. We need a bigger table! Right! The next thing we're going to put in is some of this. Who can tell me what this is?

C. Sugar (chorus).

T. Now! Then! Is sugar always white?

C. Yes.

C. No.

T. No. Sometimes you can get ...

C. Brown.

T. Sometimes you can get brown sugar. I've even seen multicoloured sugar. Special sugar for putting in your coffee. Lets have a look at this and see what colour it is.

C. White (chorus).

T. Does it look the same as the flour?

C. No.

C. Silver.

T. It's a bit sparkly isn't it, this sugar? Yes you're right. ...

T. Now, Christopher had a name for this. What did you call it Christopher?

C. Sticky milk.

T. Yes, you're right. It is sticky milk. It's called condensed milk. It is sticky. It tastes delicious. If you're very, very good I'll let you have a taste.

T. Ooh, it runs right off the spoon. Can you see? Sticky milk. Now let me see. I don't think I'd put my hands in there, they'd get all sticky. So we've got flour, sugar, and condensed milk - sticky milk, condensed milk.

T. Something else! In this packet is something called ginger. It's a special ... it's a special spice. Who's had ginger snap biscuits?

C. Me! (chorus)

T. Well then you'll know. You'll know what ginger tastes like. And ginger isn't white, not like the flour and it's not a sort of creamy colour like the milk. It's that colour there, ginger. You've got to be very careful because ginger makes you sneeze if you put it near your nose. So don't go too close or else you'll sneeze into the biscuits!

T. Let me just check. This is my recipe book sheet. Oh! I need something else. What else is on the table that I haven't put in? Margarine. What colour is the margarine?

C. White.

T. It's yellow. Will the margarine drop off the spoon?

C. No.

T. No, it's not like the milk. It tends to stick. So I'll have to just ... tap it like that ...but it still doesn't want to come off the spoon. It's also quite sticky.

T. We need this flour to dust onto the table...are you listening Tom? For when we roll the biscuits, because the biscuit mixture's going to be very sticky. Christopher called this sticky milk. So we need this for later on. Right! Who would like to have a taste? One finger ... You can dip your finger into whatever you like for a taste. Now, Christopher, you start.

T. Do you want to taste something, Gemma? ... James? Does that taste good? Does it taste sweet, do you think? Does it taste sweet? ... Would you like a taste, Darren?

C. Yes.

T. I know what I'd be tasting.

C. I taste the bu'er.

T. Would you like a taste?

T. Do you like the ginger?

C. I like sugar, I like sugar!

T. Which of these do you think will taste the sweetest? Don't touch, just tell me. Do you think the sugar will taste the sweetest? What do you think, Kim?

C. Sticky milk.

T. Sticky milk? I think Christopher's right. I think that's the sweetest. Sugar's very sweet as well.

C. I know!

C. Sugar!

C. I know! Butter!

T. Are you listening, David? Adam, you'll have to go and leave the table and play with something else if you're going to interrupt all the time.

T. Does the flour taste sweet?

C. No.

T. No, not really. It wasn't sweet. It doesn't taste very good, does it? Do you want to taste something else?

T. So those are all things we are going to use to make the biscuits, and I hope they turn out better than last night.

C. I haven't tasted the sugar.

T. When we've made the biscuits ... Andrew, you're not listening! When we've made the biscuits ... Gemma! Adam! When we've made the biscuits you can come and taste the different things on this table. We'll do the biscuits first.

T. Now, we got to do some weighing and measuring. Let's start off with some margarine. Who can point to the margarine? Right. Jamie, we're going to start with the margarine. We need 160 grams. We'll have the big spoon. Right. Can you see, Christopher? Can you see the red pointer? Can you see it moving? Is it moving? I would like it to point to there. Can you see the number two, there? It's got to come just before that. Right! You tell me when the red line comes to there. You keep watching. Is it there yet?

C. No.

T. Is it there yet?

C. Yes.

T. A tiny bit more! Right! We'll pop that into the bowl. We've got some margarine. Now, you'll have to do some hard work for me. This time we're going to put in some sugar. I'm going to let ,er, Jane and Rebecca and Stephanie watch the red pointer. Can you see the red pointer? Careful. Can you see it move? When that red pointer gets to that little mark there, just before that big mark, right, just before there. Now, just see, are you watching? Tell me when it's there. Is it there yet? Does it need more or less?

C. Less.

T. Less? Or more?

C. More.

T. More, I think. Yes. Is it there yet?

C. No.

T. Are we there yet?

C. No.

T. Tell me when to stop. We should stop about now?

C. No.

T. I don't want it quite at that...I don't want it quite to reach that mark, there. See! It's just a little way away. That's just about right. Put it into the bowl, please. We're going to make them... We're going to make them into little cakes, and when they're baked we're going to break them because there won't be enough for everyone.

T. Right! This time, it's time to put the condensed milk in, this lovely sweet, sticky milk. Now, I've got to measure...

C. All of it?

T. Oh, no, not all of it. That would be far too much. I've got to measure three ounces, it says.

T. I won't put that much in, because the biscuits I made last night were far too soft. Right, umm, now, here it is. Now, watch this trickle in. Are you watching? Are you watching? Here it comes.

Wooh, lovely sticky milk!

C. It looks like rain.

T. It looks like the rain, does it?

C. Yes!

T. It's very runny, isn't it? The margarine didn't pour in like that, did it?

C. It's like the sugar.

T. There, its covered... its nearly covered all the sugar. See if we can make all the sugar disappear underneath it...can you see? Ooh! where has the sugar gone? There's a bit! See if we can get it! There it is. There's a bit there.

T. Right, this is when you'll have to start doing some work for me, because we're going to do some mixing, and we'll just make a space. Now, you will all get a turn, so please don't say, "Me! Me!" all the time.

T. Right, Jamie, will you stir it round and round and round. All mixed together so that you cannot see the sugar and you can't see the margarine and you can't see the condensed milk. Until it looks all just one big ... sticky mess.

C. I stir sugar.

T. Round and round and round... Pass it on to Nathan. Let Nathan do some stirring. Oh, the sugar! Where's it gone? Can you still see it?

C. I can see melting sugar.

T. It looks as though it's melting. Right, pass it round. Adam, stir it round. How many people help their mummies bake?

C. Me. (chorus)

T. Right, now you'd be better with your sleeves up. Oh, you're all right, yes. You've got short sleeves. Can you see the sugar?

C. No!

T. Where's it gone?

C. Gone in ... side it.

T. Would you like a go? It's your turn. It's all yellow, its all the colour of the margarine. All that sticky milk's gone into it as well.

T. Stephanie is stirring in all the bits from the side. Is that the way you do it at home? It looks delicious. Can you remember what's inside it?

C. Sugar.

T. Sugar and.. what else? Sugar, sticky milk and margarine. That's a great name for condensed milk. I like that. Stir it round and round. Where's the sugar gone? It's disappeared. I think it's melted into the milk and the margarine. Right. Stephanie, pass it on to David.

C. I can get some on my hand.

T. Vanessa, I'll give you a turn.

T. Right, pass it round! Pass it round!

T. Don't forget there's some on the side (of the bowl). Can you mix it right down? What? What did we not put in? Oh! Did you remember? Children, what do we put in next? Tom, Can you remember?

C. Milk.

T. What? What have we not put in? Well, we've put the milk in, we've put the butter in, we've put the butter in. We haven't put the ginger in, but there's something else. Julie what else have got to put in?

C. Ginger.

C. Flour.

T. Ginger. Ginger and

C. Flour.

T. Chrissie's turn. Ooh! You can tell this boy does it at home. My goodness me., what a beater! I can remember my Mum, putting the bowl under her arm, you know reallyJane, What's that? What is it called?

C. A tea strainer.

T. Its a bit big for a tea strainer. It's a sieve. Listen. Listen to it. Can you hear the noise it makes?

T. Right! Now it's the turn of the flour and the ginger. Now, we need the scales. We need the scales to weigh the flour. We need 250 grams of flour. This side, let me come round. We want the red pointer to go to nearly that part there. You see that little mark there? We want it to go nearly onto that little mark there. Are you looking, Julie? Tell me when to stop. Is it at the 2 yet?

C. More, more.

T. Now. Who's got the sieve? Does your mummy use a sieve, Christopher? What does she use it for?

C. Biscuits.

T. Does she put biscuits into the sieve? What does she put into the sieve?

C. Flour.

T. Why does she put flour into the sieve?

C. To make biscuits.

T. Well, can you see the flour? Can you see, what's that? The flour. Is it all smooth? Who can see some lumps? Let's see what happens when we put it into the sieve? It's just like snow. This is nice. Have a look and see if there are any lumps coming through. Are there big lumps coming through?

C. No.

T. Christopher, Is it hard or is it soft?

C. Soft.

T. Is it as cold as snow?

C. No.

Nooo! I think you've got enough! Rub your hands. We're going to use that in a moment. Now, we've got some more to do. All the lumps have gone, can you see.

T. Right, here goes. No, not in your hands this time because we need it all for the biscuits.

C. We could do that on our heads.

T. Well, I don't think you would be very pleased if we did that on your heads! What do you think we have to do with this now?

C. Stir it!

T. Stir it all in. Now, this time we're going to start with Christie. Christie, could you start to stir in the flour, very carefully.

C. It's very hard.

T. You have to do it very gently to begin with. Then you can go harder and harder as you go on.

T. Ooh, what a floury face!

C. It looks like a snowman, a snow lady. Ha, ha.

T. Now, what's happening to the flour? Is it still white?

C. Yes.

C. No.

T. What colour is it?

C. It's yellower.

C. Yellow.

T. I wonder why?

C. Cos the butter.

T. Because of the butter. Do you think the flour's gone into the butter and the sugar, then?

C. It looks all wet now.

T. It certainly does. The margarine takes the flour into it. It's not soft and dry any more, is it?

C. No.

C. It's soggy.

T. It's quite soggy. It's quite sticky, I think.

T. Have a feel of that. Pass that round, Julie, have a feel. Pass it round. Let everybody feel, what it feels like. It doesn't feel the same as the flour that we put in, does it?

C. No.

T. Feel the difference.

C. Very sticky.

T. It's very different from the flour isn't it?

T. Can you pass it round?

C. I've got messy hands.

C. Feel it.

T. You're going to need floury hands. It's quite good to do that, for when we roll out the pastry. Rebecca! Can you carefully put the scales onto the table behind you... Rebecca! If you lift the scales up... Rebecca! Lift the scales up, and put them on the table behind you. Lift it up! Put your hands under, like this. Lift it up, carefully. Lift it up, and carry it over, and put it on the table behind you. That's it! Thank you!

T. This is page two. There we are. This is where we put a bit more flour in.

C. You haven't mixed it round.

T. Right, can you mix that in for me, please.

Adam! Are you making biscuits, or are you playing? You decide. If you're making biscuits, stay. If you're not, then off you pop, please. Thank you. Pass it round, in case anybody wants a feel.

C. I did have a feel.

T. You've had a feel, right. Have you had a stir yet, Melissa? Nearly ready. That helps you feel how sticky it is.

T. Kim and Kerry, will you please not play with the tray. We're going to put the biscuits on that, to bake them.

T. Right, next. Oh, dear, do you know what I've forgot to put in? It's too late, I think. We'll just have to make them not ginger biscuits! You forgot to tell me to put the ginger in.

C. I could tell you.

T. Oh, Christopher, I wish you had. It had to go in at the same time as the flour. Never mind, they'll just be sweet, sugary biscuits. That's all right, isn't it?

C. I like it.

T. Now, it's Christopher's turn. Let's see how Christopher makes biscuits in his house. You know, Christopher sometimes brings jam tarts and biscuits for the teachers for their coffee, don't you, Christopher, that you've made with your mum in the morning. We often get treats.

C. You have to have more. I love you.

T. Oh! That is sweet. Thank you very much. Oh, you've made my day, Christopher.

T. It's Kim's turn. It will soon be time to roll and cut these biscuits. Then what will we do when they're all ready?

C. Put them.

T. Put them where? In the fridge?

C. The cooker!

T. Put them in the oven. That's right. Ooh! Is it heavy and sticky, now? Let me have a feel. It is, isn't it?

T. Here's a little job for you, Hayley. Can you just rub your finger, like that, all over the tray, please. With your fingertips.

T. Who's here? Stephanie! Stephanie and Christina, will you rub that over with that paper, please?

C. Uhh!

T. Uhh, is it sticky? And now I think you need something to wipe your fingers. Here's a towel to wipe your fingers.

T. Right, Stephanie! It's your turn to mix the biscuits this time. And then it's time to roll them out. And we need this... er... this shaker. Will you pass this round, and I want you all to shake a little bit of the flour onto the table, just like that. Tap the bottom of it. Would you like to tap it? Ooh, that's it. Would you like to do that? What's happening when you do that?

C. It's coming out.

T. It's coming out of the holes. Give it a good bashing on the bottom.

C. I will!

T. Ooh, not on the tray, though.

C. I can do that.

C. Mine.

C. It's in my hand.

C. Can I do it this way, now?

C. I know what's cooking!

T. Yes, but you don't know what the shapes are yet.

C. I do.

T. No, well, we'll have to wait and see. Right. Are you ready? Are you ready to look? What do you think this one is?

C. Bus.

T. You think it's a bus. I think you're right. I think it's a bus. Where would you see a bus?

C. A bus stop.

T. That's if you're going to catch a bus. You're right. What about this blue one?

C. Car (chorus).

T. What about this one?

C. Tractor (chorus).

T. This one?

C. Lowwy.

C. Lorry.

T. Now, what have they all got? What have they all got to make them move?

C. Wheels.

C. Wheels (chorus).

T. They've all got wheels, and you can go in a car, and you can go in a bus, you can go in a tractor, and you can go in a van.

T. Adam, I forgot the ginger. Never mind, we're going to have biscuits that aren't gingery. Now, let me just have a feel, to see what it's like. Are you ready to do some rolling and cutting?

C. Yes.

T. Now, there are quite a few of you here. I don't think you should eat it yet. When do you think you should eat it?

C. When it's cooked.

T. When it's cooked. I think that's a better thing to do.

T. Now, I'm going to start over at this side. We're going to start here, with Julie. We're going to roll this out ... We need a little bit of flour here. Now, I want you, Julie, to carefully roll this out. Carefully, with the rolling pin. Now, Julie, what shape would you like to cut your biscuit? We need to put some flour on the biscuit cutter, because the mixture might stick to the biscuit cutter, and then the biscuit wouldn't come out.

T. Right Julie, would you like to cut out a nice bus? Lift it up carefully. We'll pop it ... just like this ... I'm just going to use this spoon to help me. I'm just going to ease it gently, so that it doesn't break. Oh, look at that lovely bus! Right, come on then! You're going to make two each. You're going to make a car. Right, into the flour. Put it in. Ooh!

C. Brrum, brrum.

T. Have a think, whether you're going to make tractors, cars or buses.

C. I know what I'll do. I'm doing a tractor and a wagon.

C. I'm doing a tractor and a lorry.

C. I'm doing a lorry.

C. And I'm doing a lorry.

T. Oh, isn't that a super car?

C. Brrum brrum brrum brrum.

T. Right. Kim's turn now. Kim, what what would you like to have? A tractor?

T. Erm, a car. Two ... you can have two each. Now, just roll this out. Can you see what's happened? It's getting bigger.

C. Bop, bop bop!

T. Right, you do those two for me. One, two. Just count them out for me. Did you get them out, Kim? Beautiful, perfect. And, er, what was the other one you were going to do?

C. Bus.

T. A bus.

C. Adam's a naughty boy.

T. He's not! He's my friend, aren't you Adam? Poor Adam! I can't imagine why he's naughty.

C. Because he's saying naughty words.

T. Oh, I think you must be wrong. His mummy wouldn't like it. Your mummy wouldn't like it Kirsty, if you said naughty words. She'd be very upset.

T. It's your turn, Adam. Would you like to roll it out for me, please? Ever so gently, that's right. Ever so gently. Make it bigger and flatter. Ooh my goodness! You're going to have to wash your hands after all this, aren't you? Try not to push it down. Try just to roll it across. Don't push down. Oh, that's broken off. So we don't need that. What shape are you going to cut it, Adam? Have you decided?

C. Yes.

T. What would you like? The van and...? The car. Right. Cut it out. Wonderful! That's a good van, isn't it? Pull it out carefully at the top. There, and the car. Oh, good, that's come away well, Adam. Well done! That's lovely.

T. Right, who's next? Christie. Christina Hamilton.

C. 'Tisn't her name!

T. That's her name. Christina Hamilton. Didn't you know that?

C. It's Christina.

T. It's Christina Hamilton. What's your name? Stephanie ... Stephanie what?
 C. Yaxley.
 T. You're Stephanie Yaxley, and that's Christina Hamilton.
 C. Knock, knock!
 T. Who's there?
 C. Rick!
 T. Rick who?
 C. Rick Wall!
 T. Ooh! Very funny, very funny!
 C. KnockT. Who's there?
 C. Mister Parrot is on his way to your house!
 C. Knock, knock!
 T. Let's save the jokes till while they're cooking. While they're cooking we'll have a joke session, how about that?
 T. Have you finished, Adam?
 C. Yes.
 T. I think we'll be eating them tomorrow! I don't think they'll be ready to eat today! Right! Whose turn is it now?
 C. Mine!
 T. Right! It's Stephanie Yates' turn. Not Christina Hunter this time! Right! Dip it in the flour... Roll it out... Roll the biscuit mix out. Gently, sweetheart, other wise it won't be ... Oh, dear! I tell you what! Put it all together again. Mix it into the bowl again, and cut it again. I think the rolling pin's a bit sticky, so we'll put some flour round. Flour's very good, you know, it stops things from sticking.
 T. Right, try again. This time do it ever so gently. Don't push it too hard.
 T. Don't lick it, please You can lick it when it's all done. When your Mum does the cooking, do you like to get the licks, when Mum makes cakes?
 C. Yes!
 C. Yes!
 T. It's lovely and smooth. Right! Put it on the tray.
 C. Do you know what? It sticks to my (undecipherable) in my house.
 I know. And especially on a warm day, for some reason it seems to stick.
 T. You've a lot of bits to play with, haven't you? Look what's happened to Rebecca's, the same as Stephanie's. It's broken up. that's because you have to be really, really gentle.
 C. That's what I do.
 C. I made erm, chocolate biscuits.
 T. What have you made?
 C. Tractor.
 T. Good girl. Are you going to make your biscuit and then go outside. And then I'll let you know when it's cooked. Would you like to do that? When you've made your biscuits. Look at that. Oh, look at that lovely tractor! Oh, well done. That's a really good tractor. Now what else would you like, Rebecca? A little van.
 T. Oh! Isn't she good? Can you see how gently Rebecca's doing this? Well done, Rebecca.
 T. Oh! Jamie! We did say later, but not now. You've waited very patiently, waiting your turn. You've waited quite a long time.
 T. There we are. Well done, Rebecca! You'll all get a go, don't worry. Right, Lorin's turn. Can you pass the cutters over to this side of the table, please?
 T. Thank you, because Lorin wants a turn. Let's see which biscuits she wants to make. Look at how many cutters there are. Stephanie!
 T. Right, Lorin! Did you see how gently to roll it? There we are, Lorin. See if you can do it very carefully... Well done... Which way round is it goin to fit, do you think?
 T. If you've finished making your biscuit and you would like to go out, off you go. You may have to go and wash your hands.
 T. That's you done! Who's next?
 C. (child comes up to the table) Can I make one?
 T. Toby, if there's some mixture left at the end, then you can make one, yes.
 C. Look at my hand!
 T. The mixture's really breaking up now ... it's sticking badly. Ooh! That's a good one, isn't it?
 C. Why are you baking biscuits?
 T. Why? Why should we make biscuits? It's a good thing to make. I think we're making biscuits because I like eating biscuits.
 T. Jamie, you've been waiting a long, long time to make the biscuits. It's your turn at long, long last. That's very good. (aside to researcher) This is a little boy who er, who can't stay still.

T. Really good! Right! That's that lot ready to go into the oven. Jamie, I think we'll find space on this tray for your biscuits. We'll have to move these other ones up. We'll just have time to cook them before the mummies come.

C. I'll stay here.

T. You're going to stay there! And watch, and help. Are you going to help with the washing up?

C. Look at my playdough!

T. Can you make it like last time? Can you squeeze it all together? Can you squeeze it up into a ball? It looks very, very crumbly to me. Gently, Jamie. Gently, otherwise it will break. very gently, very gently. Slowly backwards and forwards. That's it.

T. The birds are going to enjoy this, when we shake this table out.

C. What?

T. The birds will be able to er, to come and peck at those if we throw those out into the garden. Julie, what shapes would you like? The tractor.

C. They'll like the crumbles.

T. They'll like the crumbles! I've nearly done Yvonne! (to the other teacher) It's taken longer than I thought! Which other shape are you going to use, Jamie? Have you decided?

C. Er, that one.

T. Will it fit on that little bit of mixture? Do you think you're going to need some more? That's it! That's good.

C. Why do they all break up?

T. Well, because it's a very crumbly mixture, Toby. Very crumbly indeed.

T. Adam, have you made a biscuit? No! I'll just pop these in the oven. Right, Jamie, we don't need the flour in it, so we're going to shake it back into there, like that. Does your mummy do baking?

C. Yes!

T. What does your Mummy bake, Jamie?

C. Cakes.

C. Mine does!

C. Mine makes cakes!

T. Does Grandad make cakes, Jamie?

C. My gran makes ... chips.

T. Oh! When do you have chips? Do you like chips?

C. My gran makes, erm, chips.

C. Do you know what? My mammy bakes chips!

T. She bakes them. Does she bake them in the oven, or does she cook them in the pot?

T. Adam, I'm just going to pop these in the oven and then I'll come back and help you with yours. Would you carry this to the oven for me, please?

T. Now, this is the job that nobody likes - the tidying up, to do. Who wants to taste the stiky milk?

C. (chorus) Me!

T. Do you want some? Come on then! Open up!

C. I want some.

T. Adam, would you like a taste? Does it taste sweet, do you think?

All go off to the sink to clean the dishes.

Some time later, the children are sitting down, and the biscuits are brought in from the kitchen.

T. Now, the biscuits are not soft and squishy any more! They are quite hard. Listen! They've baked quite hard in the oven. What is this one?

C. (chorus) Car.

T. Let's not shout out. Let's ask Jamie. Jamie, what it?

C. Lowwy.

T. A lorry, well done. Erm, Stephanie, what shape's that one? Can you see the wheels?

C. Bus.

T. Gemma. Can you tell me what this one might be?

C. Car.

T. Car, and a tractor. Do you remember it was the tractor, the one where the wheels kept falling off.

C. Tractor.

T. Before you go home, would you like a taste?

C. Yes (chorus).

T. We'll just break up some tractors. I would like a taste. We'll only have tastes if we are sitting nicely. Would you like a taste, Daniel? Jamie, would you like a taste? Does it taste good?

C. I like the tractor.

T. You've got a back wheel, you've got a front wheel.

C. And a front wheel.



T. Right, let's break the car in two. There aren't enough for everybody to have one. Stephanie, would you like some.

C. (chorus) Me!

T. Oh! Only if you're sitting nicely.

Teacher distributes the rest of the biscuits as the mothers arrive to take the children home.